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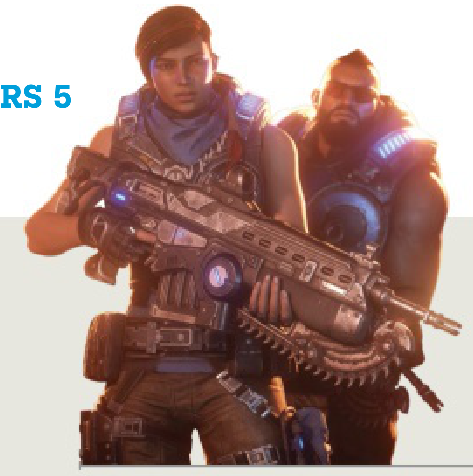

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Alan
Dexter

BUILD AN EFFICIENT AND SOLID FOUNDATION

FOCUS IS IMPORTANT. When it comes to building PCs, it enables you to spend your cash where it will have the most impact. Pump the lion's share of your budget at the processor if you're going to be doing a lot of number crunching, at the graphics card if you're a gamer, or at the storage if you've got a lot of data to plow through or you're building some kind of NAS. But what do you focus on when you're building a more general-purpose system? Where should your hard-earned cash go?

This issue, we show you how to build such a system, with the added benefit that the resultant machine won't break the bank. It absolutely works as a fully functioning PC, and thanks to shifts in processor capabilities, it will handle workloads that would have required much more expensive hardware only a couple of years ago. Even so, this isn't really what the system is designed for—it's meant as a foundation for a more focused machine. So, not only do we show you how to piece it together, but we then go on to show you how to upgrade it, depending on what you've got in mind.

When embarking on such a build, the initial pivotal decision is generally whether you should go for AMD or Intel. Given the recent shifts in the market, it probably won't come as much of a surprise to discover that we've sided with AMD here, with the latest Ryzen 3 3200G. This uses a Zen+ architecture as opposed to the Zen 2 architecture that can be found powering the rest of the 3000-series family, but don't let that put you off what is an incredible budget powerhouse. If you wish to side with Intel, however, its slightly more expensive Core i3s would be a good starting point (with a similarly affordable motherboard).

Looking at the budget end of the spectrum shows that PCs really have come a long way recently, something that is highlighted by our big feature on the history of the PC (pg. 40). You may have an idea of how some of the bits and pieces that define the modern PC came about, but actually seeing how it all started makes for an epic story, and it's well worth a read. It may change how you view some of the players involved.

Our other big feature looks at the best options for taking control of your password manager (pg. 52). It's all well and good using an online service, but you're not really in control, you're just putting your security into the hands of others. What you should do is run your own server, possibly from your NAS, that handles all the hard work for you.

We also show you how to take charge of your media, converting videos so they stream glitch-free across your network on any connected devices. Speaking of which, we also show you how to install Kodi on your Amazon Fire TV Stick, so you can get it to do so much more with your TV than simply stream shows from Amazon. Given how cheap Fire TV Sticks are, it's a great way of making even the dumbest TV a smart device.

I hope you enjoy the issue.

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

intel
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Intel's New Top Dogs

Intel's HEDT chips get a little faster and a lot cheaper

INTEL HAS some new high-end processors: 12 chips aimed at the HEDT and workstation market. No, they don't sport a new core architecture or a die shrink. They are all iterations of existing designs, but they are faster. And much cheaper.

Of most interest to us are the four new Cascade Lake X-series chips, aimed at the high-end desktop market. The top model is the Core i9-10980XE, with 18 cores, a base clock speed of 3.0GHz, an all-core boost of 3.8GHz, and a maximum boost clock of 4.8GHz using Intel's Turbo Boost Max 3.0. Below this is a i9-10940X, with 14 cores, a base clock of 3.3GHz, and a maximum boost of 4.8GHz. Then we have the 12-core i9-10920X, with a base of 3.5GHz, and the same maximum. At the bottom is the i9-10900X with 10 cores, a base clock of 3.7GHz, and a maximum boost of 4.7GHz.

These are decent rather than startling speed bumps, between 100 and 200MHz for the most part. There are some useful new features, too. You get 48 PCIe lanes on the chip—four more than the existing X-series chips, bringing the platform number up to 72 lanes. You also get Wi-Fi 6 support, and four-channel DDR4-2933 memory, with a maximum of 256GB, double the previous maximum. There's also Intel's Turbo Boost Max 3.0, which "intelligently" manages core speeds for optimal performance, and knows which core can be pushed the hardest. Thunderbolt 3 and Optane 905P SSD are supported, too.

The feature Intel is making the biggest noise about is its Deep Learning Boost, which accelerates AI performance by around 2.2 times. Intel claims it puts "new classes of computing performance and AI acceleration into the hands of professional creators and PC enthusiasts." AI is rapidly becoming an important metric, as it works its way into many applications, particularly on servers; it's creeping into games, too.

> “Intel has thrown every feature it has at the chips, and slashed prices.

It's the pricing that makes these new processors stand out, though. The i9-10980X is just $979, the rest of the chips come in at $784, $689, and $590 respectively. This is a huge drop from existing models; the old 18-core i9-7980XE was listed at $1,880 when Intel announced these. The new chips cost between half and three-quarters of the price of the chips they've replaced. The cost per core has dropped from around $100 to about $50—at a stroke, Intel has lopped hundreds of dollars off the price of building an HEDT. That can't be bad.

Intel also has a new batch of W-series chips for workstations, eight in all, from the W-2295 through to a W-2223. These sit at the top of the W-series 2000 models, aimed at single-chip systems. Performance gains are modest, AI aside, but again the pricing is paramount. They start from just $294 for the W-2223, and run to $1,333 for the 18-core W-2295. The older 18-core W-2195 was $2,779. Why such dramatic price cuts? In a word: Threadripper. AMD has put so much pressure on Intel, it had to respond, and the simplest way to do that is to drop prices. Intel doesn't have a new core architecture ready yet, so it has thrown every feature it has at the chips, and slashed prices. The company has resisted a price war until now, but it is losing market share. AMD has more to come, too; its third-generation Threadripper is due this year.

Intel has also revised the pricing on its Core S-series (the regular desktop ranges) without integrated graphics (the ones with the F suffix). When these first appeared, they were priced the same as chips with integrated graphics, which was disappointing. This has been adjusted, and prices have dropped across the range. The changes affect OEM bulk prices, so will take a little time to filter through. Before you get too excited, it's only a drop of $25, but that's better than nothing.

Is this the beginning of a price war between AMD and Intel? Probably not—both companies are struggling to meet demand, and the PC market is still quite buoyant. Neither company can afford a protracted bout of price cuts, but Intel has certainly made a strong statement of intent. The fight is on. **–CL**

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NAVI GOES MASS MARKET

It'll power "world's most technologically advanced 1080p gaming desktops"

AMD'S IMPRESSIVE 7nm GPU has reached the mainstream with the release of the RX 5500 and the RX 5500M (M for mobile), based around a new Navi 14 chip. These are aimed squarely at 1080p gaming. The RX 5500 has 22 compute units and 1,408 stream units—about two thirds of an RX 5700. The desktop version has a game frequency of 1,670MHz; the mobile version is clocked at 1,448MHz. Both have 4GB of GDDR6 main memory, with 8GB as an option for the desktop. The memory interface has been dropped from 256-bit to 128-bit; AMD says the RX 5500 has been "tuned" for 1080p. To be fair, the effective memory speed hasn't suffered—it's 14Gb/s, the same as the RX 5700. The RX 5500 has all the fancy features of its bigger siblings, too, such as FidelityFX, Image Sharpening, and Anti-Lag. The M version has a TDP of 85W; desktop version 150W.

Initial performance figures show the RX 5500 can crank out frames between an RX 580 or GeForce GTX 1650 and an RX 590 or GTX 1660. AMD quotes the RX 5500 as being 12 percent faster than the RX 480. It was particularly keen to show the RX 5500 against the GTX 1650, where it was "up to 37 percent faster." The RX 5500 will appear first via OEMs, while standalone cards should be ready for the holiday season. No firm prices yet; we hope about $150.

Nvidia is preparing a GeForce GTX 1650 Super in response, expected to use the same TU116 GPU, but coupled to faster GDDR6. The RX 5500 isn't groundbreaking, but it's a vital step for AMD toward breaking into the mass-market system builders arena. We can expect more from Navi soon, too—there's a high-end Navi 12 due, and a closer look at this Navi 14 shows it has 24 compute units on the silicon, so there's room here, too. **–CL**

MICROSOFT HIDES ACCOUNT OPTIONS

WANT AN OFFLINE WIN 10 ACCOUNT? IT'S NOT EASY

Sign in with Microsoft

IT IS NO SECRET that Microsoft wants you to have a Microsoft account. It has become increasingly difficult to avoid one when setting up Win 10. Recent reports stated that the option for an local account has disappeared altogether. It hasn't, but Microsoft has hidden it. The trick? To create an offline account on Win 10 Pro, you have to select "Domain join instead." Pretty sneaky, hiding the option behind something else. The situation on Win 10 Home is worse. There is no offline account option since the May 2019 Update. Microsoft's advice is to create a Microsoft account, complete the installation, then go back into Settings, and delete it. If you are more determined, you can disconnect from the Internet, skip through the "something went wrong" error message, then create an offline account as before, but don't connect again until you've finished. **–CL**

PAYPAL LEAVES LIBRA

Wheels start to come off Facebook's currency project

FACEBOOK'S LIBRA project plans to create a border-free electronic currency. The original 28 backers included some big names in finance, but one of these, PayPal, has dropped out—it was concerned about money laundering and the growing backlash. It doesn't end here either; Mastercard and Visa are said to be having second thoughts. As Visa's chief executive said, "No one has yet officially joined," and its decision to join will determined by Libra's ability to "satisfy all the requisite regulatory requirements." This is the stumbling block. Despite doing nothing that isn't already possible, Libra has come under heavy fire from regulatory bodies (it looks likely to be banned in the European Union, for example). Facebook could push through alone, but that would only fuel its detractors. Among these are such big names as Apple's Tim Cook, who said, "I really think that a currency should stay in the hands of countries. I'm not comfortable with the idea of a private group setting up a competing currency." **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **BRAIN-CONTROLLED SUIT**
A quadriplegic man has walked again using two brain implants and a powered exoskeleton.

✓ **BLACK IS BLACK**
BMW has covered an SUV with Vantablack, a carbon nanotube material that absorbs 99 percent of light; it's like looking at a hole.

✓ **XCLOUD GOES BETA**
Microsoft has starting accepting sign-ups to use its game streaming service; slots are severely limited, however.

TRAGEDIES

✗ **BRICKED MACS**
Macs running Avid have mysteriously started crashing, and can brick if rebooted. Parts of Hollywood have been hit hard.

✗ **BE SMART**
Tesla's new Smart Summons feature has lead to a number of "incidents." Tesla has warned that it requires the use of "common sense."

✗ **RIP GEAR VR**
Samsung won't support Gear VR on its new phones; few used it.

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More PlayStation 5 Details Emerge

MORE SNIPPETS ABOUT the next Sony PlayStation have been confirmed by PlayStation CEO Jim Ryan and system architect Mark Cerny. The official name is PlayStation 5 (no surprises there), and it's due on sale by November 2020, ready for a showdown with the next Xbox. It has been confirmed that the AMD-supplied Navi GPU has hardware ray tracing built in, as well as 8K support if your screen can handle it. Game storage is on SSD, and much effort has been put into reducing the footprint of games by removing duplicated data, and allowing for partial or modular installations. Games will load about 15 times faster, too, helped by PCIe 4.0 support. Physical games will use 100GB optical disks, with the optical drive doubling as a 4K Blu-ray player.

The UI has been worked over to show more information about a game before you launch it; you'll be able to see your progress, or if your friends are playing, before you join. The new controller, the DualShock 5, will have adaptive triggers with variable levels of resistance, so different functions will feel different, such as giving weapons different trigger pulls. A lot of work has been put into the rumble, too, to try to simulate different surfaces. Another confirmed feature is a new power-saving mode that uses just half a watt. The PS5 will also be backwardly compatible with PS4 games. There will be some sort of cloud features, too, but specifics remain a secret.

Sony isn't giving much away about the hardware, but we do know it's set to be based around a high-end eight-core AMD Ryzen processor, and there's a custom audio chip, claimed to be "profoundly different." It's still over a year away, but the PS5 is generating quite a buzz. Microsoft is going to have a fight on its hands. **–CL**

BostonDynamics

Robot Dog for Sale

After years of amazing us with videos of robots, Boston Dynamics has put a model on sale, or rather lease. A four-legged robot called Spot is available to selected "early adopters." More general sales are expected to follow if all goes well. The 2.75ft-tall robot can walk at 3mph, carry a 30lb payload, cross rough terrain, and even work in the rain. The swappable batteries last 90 minutes. Spot is programmable, and comes with a range of accessories. Expected tasks include construction, delivery, security, and home assistance. How practical Spot will be is debatable, but it is hypnotizing to watch it walk about; it looks uncannily biological while clearly being a machine. No exact price has been revealed, but Boston Dynamics says it will cost the equivalent of a luxury car. **–CL**

The Galaxy Fold returns

Samsung's Galaxy Fold is back, after its debut was cut short by multiple screen failures. It has been redesigned to be more durable. Samsung claims the Fold is now good for 200,000 folds. The first thing many testers decided to do is try to break it. In one test, it reached 119,380 folds. Not bad. iFixit, whose breakdown of the original caused such a fuss, has taken this new version apart, too. The verdict is that it's better, but the changes are largely superficial—it's still alarmingly fragile. The list of warnings it comes with paints quite a picture. You must keep it away from objects such as coins, credit cards, dust, and fluff. You must only touch the screen lightly, and never fold it back on itself, or twist it. The Galaxy Fold starts at $1,980—that's a lot to lose by shutting your phone too hard. **–CL**

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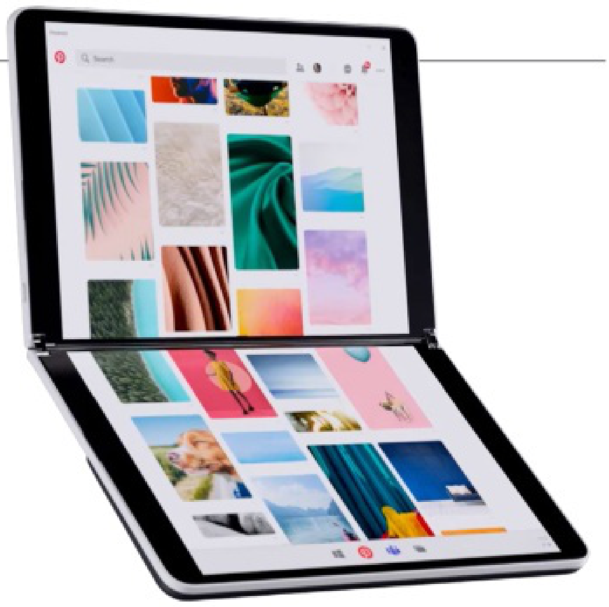

SURFACE SHOCK

Microsoft hardware gets innovative and stylish

MICROSOFT has a sketchy history of making hardware (bar the Xbox), but its Surface series has shown that it can produce decent gear, and the latest additions to the family continue to impress.

First is the Surface Pro X, a superslim two-in-one tablet powered by a custom 3GHz Qualcomm ARM processor, boasting 13 hours' battery life. It has extremely narrow bezels on the 1880x1920 screen, is just 0.28 inches thick, and weighs 1.7lb. It is beautifully light and thin. Prices start at $999, and it should be available now.

More startling are the Surface Neo and Surface Duo, two dual-screen folding devices. The Neo is essentially two 9-inch screens connected by a 360-degree hinge. It boasts the thinnest LCD screens ever created, according to Microsoft. There's a keyboard that attaches magnetically to one screen, the remaining portion of which becomes a smart bar, or Wonder Bar, as Microsoft has it. It's powered by a Intel Lakefield processor, and runs Windows 10X, a new version of Windows that intelligently supports dual screens.

The Duo follows the same format, but with 5.6-inch screens. It runs Android—a surprise. Despite what you might think, the Surface Duo is not a folding phone. Microsoft is quite clear on this, having given up on phones after spending fortunes on various projects. It certainly hasn't been designed with phone use as a priority. There's no external screen to view a caller on, for example.

Both look good, but neither will be available before late next year. Prices are unknown, but likely to be fairly high. Other announcements include the fact that the Surface Pro is to get USB-C ports, the release of Surface Buds, wireless earphones, and an AMD-powered Surface Laptop 3. Microsoft seems to have learned how to make impressive gear. It's almost enough to make you forget the Zune. **–CL**

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TECH TALK

Open-Air vs. Blowers

FOR MOST OF THE PAST 10 YEARS, nearly every new high-end graphics card has relied on some sort of a blower fan for cooling. The first such designs, such as the GeForce FX 5800 Ultra, had a terrible and well-deserved reputation for being too loud.

Despite those legitimate complaints, Nvidia and AMD have repeatedly put out reference designs that used blowers with radial fans instead of axial fans and open-air coolers. There are pros and cons to both types of cooling solutions, of course.

Why were blowers desirable? All the information I've seen and personal experience confirm that a radial fan is almost always louder than an axial fan that moves a similar amount of air. Axial fans move a large volume of air at low pressure, while radial fans are much higher pressure for the same net airflow. Jet engines use radial fans—why would anyone want a jet engine in a GPU cooler?

There are two major benefits with blowers. The first is obvious: The cooler can serve as an additional exhaust fan for the PC. Considering modern GPUs can easily pull 250W or more, dumping all that heat into the inside of a PC case means you need more case fans to deal with it. But the other benefit isn't as obvious: The radial fans used in blower coolers tend to be far more durable.

I've used and tested perhaps 100 graphics cards during the past decade. I've had two radial fans fail that I can recall, and probably dozens of axial fans that eventually needed replacement.

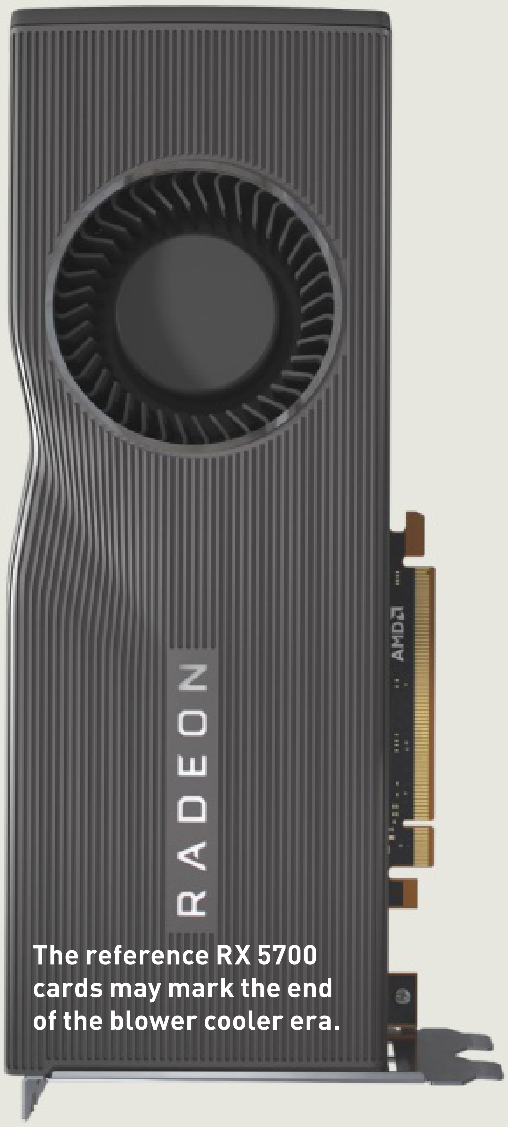
There used to be another potential advantage for blower designs. For a single graphics card setup, the choice between a blower or an open-air cooler didn't usually matter, but multi-GPU rigs often struggled with open-air coolers. I even tested a couple of desktops with open-air SLI setups that struggled thanks to the cramped quarters—one couldn't even run stable without cranking the fan speed on the inner GPU to 100 percent. Oops.

> Jet engines use radial fans—why would anyone want a jet engine in a GPU cooler?

Multi-GPU setups were standard with cryptocurrency mining, but mining pushed the hardware in ways it was never intended to handle. Running 24/7 100 percent load computations is more what you'd expect of hardware in a data center, not from consumer graphics devices used for playing games. Data center GPUs, such as Nvidia's Tesla line, typically omit fans entirely and expect the server chassis to provide the airflow.

Now cryptomining has died down and support for multi-GPU is all but dead, it's no surprise to see blowers losing favor. In the last year, both Nvidia and AMD have begun shifting to axial fan designs. Nvidia started when it switched to axial fans on its RTX reference designs in 2018, and continued with the RTX Super models this year. AMD also uses a triple-fan axial cooler on the Radeon VII, though it went back to radial fans on the RX 5700 series cards at launch.

In retrospect, that was probably a mistake—the reference 5700 XT runs very loud and hot. The noise levels of the reference RX 5700 and 5700 XT were so significant that I compared them with a Sapphire RX 5700 Pulse that uses axial fans. The RX 5700 blower generated 50.7dB(A) from 10cm with temps of 73 C on the GPU and 85 C on the VRMs. The 5700 XT was worse: 56.8dB(A) and temps of 84 C on the GPU and 100 C on the VRMs. Sapphire's 5700 Pulse dropped the noise to 44.7dB(A), with temps of 72 C on GPU and 80 C on VRMs.



The reference RX 5700 cards may mark the end of the blower cooler era.

The only time I'd consider using a blower is in Mini-ITX builds, where the compact dimensions make airflow a concern. For a microATX or larger desktop, I recommend an open-air cooler with dual or triple axial fans. Your ears will thank you, and with a couple of low-RPM case fans, you won't need to worry about overheating.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

OPEN SOURCE

Get Rid of the Gross, Bad Apples

RICHARD STALLMAN was forced to resign from MIT and the Free Software Foundation (FSF) after criticism regarding his defense of Jeffery Epstein. It wasn't the first time he'd made questionable statements. And his isn't the only instance of toxic behavior in the open-source world.

One of the biggest criticisms of technology as an industry is the proliferation of misogynistic and toxic behavior among its ranks. It may be easy to point fingers at Big Tech, but there are bad elements in open source as well. One of the biggest names, Richard Stallman, resigned from his position at the Free Software Foundation and his post at MIT after statements he made defending Jeffrey Epstein from accusations of rape and sex trafficking.

As someone who always thought of Stallman as a prophet of free software, I was surprised to learn about his statements. What disturbed me more was that he has a long history of defending pedophilia and child pornography. Reading some of his old blog posts, it doesn't get better.

While Stallman is an extreme case, Linus Torvalds was also the subject of criticism over behavior. Torvalds took time off from being the head of the Linux kernel project after outrage over his treatment of code contributors. He would publicly shame and curse-out developers who committed code that he found to be bad.

Putting aside details, the problems in the online open-source community stem from a history of being made up of mostly nerdy, white males. While there is nothing wrong with being a nerd or white (or both), there is something to be said about being in a community that lacks a diversity of voices. The toxic masculinity, misogyny, and racism I saw in the Marine Corps was also a product of the infantry being exclusively male. It doesn't surprise me that such individuals also exist in a community long dominated by men.

> “The fact someone writes good code doesn't make them unassailable as a person.

There's now lots more diversity in the open-source community. It's a minority of members who express views or create posts that are offensive and off-putting. People who head projects are in de facto positions of power, and the larger the project, the more powerful and influential the project leads. The behavior of leaders in open source ought to be subject to scrutiny, just as someone who holds a leadership role in government should be. Likewise, leadership in open source should take care to represent the wide diversity of users, developers, and community members.

Diversity anywhere results in better outcomes. Women have unique world views and concerns men might never consider. The LGBTQ community can bring unique perspectives on privacy and gender use in interfaces. People of color or differing socioeconomic status may be more aware of the barriers and challenges that disadvantaged communities face. Newer contributors may have good "stupid" questions that might go overlooked by older developers, while older developers bring experience that can be levied to mentor newer programmers. Bringing those views into how projects are designed, documented, and presented to the public is important.

Richard Stallman resigned over questionable statements he made.

The fact someone writes good code doesn't make them unassailable as a person. If free and open-source software is meant to free the user, one must ensure that the diversity of users is represented and respected, and that the developers have a grounding in morals and ethics.

While it is good and proper that Stallman resigned, his remarks still leave a stain on MIT and the FSF that will take time to fully cleanse. Every Linux user relies on GNU code that Stallman helped produce. For me, I can appreciate his contributions to open source while demanding better from people in the community.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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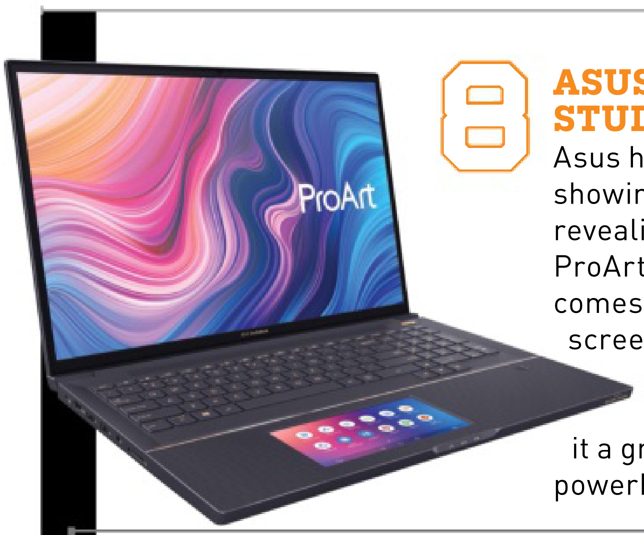
THE LIST

THE BEST OF IFA 2019



8 ASUS PROART STUDIOBOOK

Asus had a strong showing at IFA, revealing its new ProArt laptop, which comes with a 4K screen and an Nvidia Quadro RTX 6000—making it a graphical powerhouse.

7 SONOS MOVE

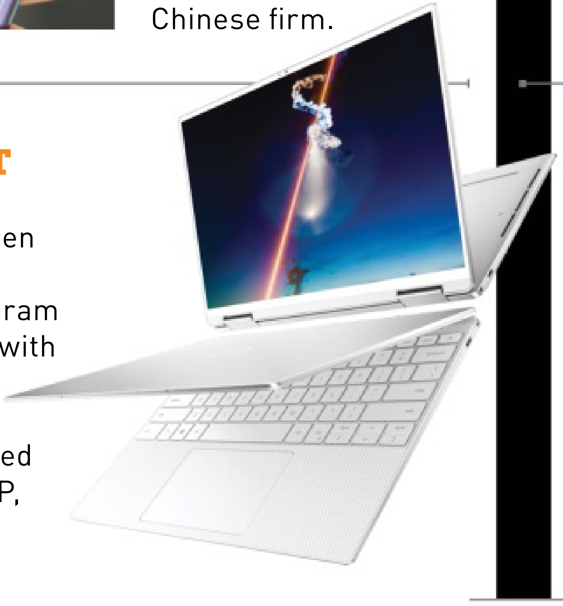
Audio giant Sonos premiered its excellent new speaker at IFA: the Sonos Move, the company's first portable smart speaker, with the glorious sound quality we've come to expect.

6 HUAWEI KIRIN 990

For those who follow mobile hardware, Huawei announced its new flagship chipset, Kirin 990, which will be powering upcoming smartphones from the Chinese firm.

5 PROJECT ATHENA

Intel was keen to promote Project Athena, its new program for creating laptops with better performance, connectivity, and battery life. Confirmed partners are Dell, HP, and Lenovo.



4 HISENSE 85U9E TV

Hisense's first foray into 8K televisions is an impressive one, featuring 4K upscaling and intelligent local dimming technology. It's also a monstrous 85 inches in size. We want one.

3 300HZ ASUS DISPLAYS

Asus unveiled the new ROG Zephyrus S GX701 laptop, which packs an almost ridiculously fast 300Hz panel. These displays are likely to become the new norm within professional gaming.

REPUBLIC OF GAMERS

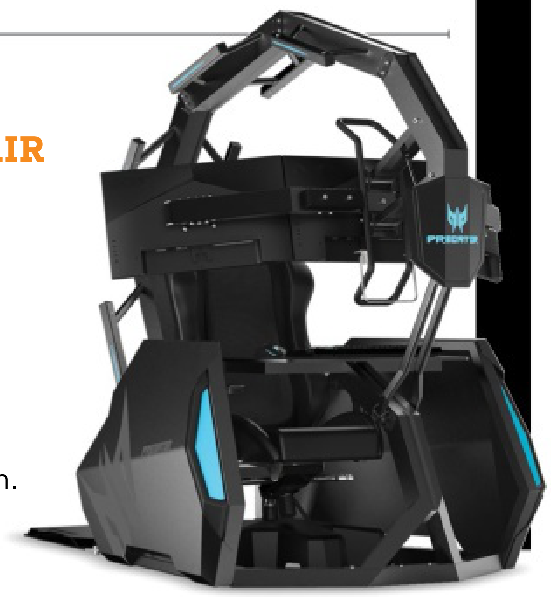
CORE i9
UNLOCKED

2 INTEL CORE I9-9900KS

The perfected form of the i9-9900K CPU, Intel confirmed an October release for the i9-9900KS, guaranteeing 5GHz all-core overclocking via a mild jab at AMD.

1 PREDATOR THRONOS AIR

A follow-up to the original Thronos, this $14,000 (yes, you read that right) gaming throne has three monitor mounts, a keyboard and mouse tray, and built-in massage tech.



© ASUS, DELL, HISENSE, ACER, INTEL

HEAD TO

BY CHRISTIAN GUYTON

Radeon VII vs. RTX 2080 Super vs. RTX 2080 Ti

The last hurrah in our series of GPU head to heads, this month we're looking at the high-end cards. We're talking 4K, baby! The focus is primarily on 4K gaming, although other elements are taken into account as well. In the red corner, we have AMD's top offering, the Radeon VII, poster boy for the 7nm GPU architecture. Meanwhile, Nvidia sits opposite with the recently released GeForce RTX 2080 Super and the older but stronger RTX 2080 Ti. There are pros and cons to purchasing any of these cards, but which one is the best? Let's dive straight in.

ROUND 1

Value

There's a clear winner in this round: the RTX 2080 Super. That's right, we just spoilered the ending to this round in the first sentence. Hope you've already seen *Endgame*. In all seriousness, though, the 2080 Super is the newest card here, and its status as a price-matched refresh of the original RTX 2080 makes it excellent value. Without costing a penny more, Nvidia improved the performance against the original model by 5–10 percent, and the 2080 was no slouch in that area to begin with.

Objectively speaking, none of these cards is particularly good value for money, especially considering that they demand a 4K monitor, too. When examining GPUs on an fps-per-dollar basis, the champions are always cheaper cards, such as the RX 580 and GTX 1660. The Radeon VII might be the cheapest of the three cards we're looking at here, but it only costs 20–50 dollars less than the 2080 Super (depending on the manufacturer) and can't come close to matching its performance. Meanwhile, the 2080 Ti is, unsurprisingly, the most powerful card on show here, but a four-figure price tag can't be justified by 10 extra frames per second when compared to the 2080 Super.

Winner: RTX 2080 Super

ROUND 2

Efficiency

The Radeon VII is, unfortunately, quite a poor card when it comes to efficiency, being the first 7nm GPU available commercially—the kinks with 7nm still haven't quite been ironed out. It does have a relatively high temperature limit (it won't force a shutdown until it hits a whopping 120 C), and it performs fairly well undervolted, but that comes with a comparable drop in performance. The base power draw is a crippling 300W; unsurprising given this card's ridiculous amount of VRAM and crazy-fast memory speed—more on that later.

The 2080 Ti is a demanding card, but it comes with the same TDP as the 2080 Super: 250W. The Super card clocks higher, but the Ti packs more VRAM, better bandwidth, more transistors, more CUDA cores.... It simply has superior architecture. The Turing TU104 architecture used by the RTX 2080 evolved to its perfect form in the Super GPU, but the 2080 Ti's TU102 design is just more advanced. While practical power use and noise are variable with any GPU (particularly if you're overclocking), the same base power draw for your system means that the 2080 Ti is—perhaps surprisingly—the most efficient card of the three.

Winner: RTX 2080 Ti

ROUND 3

Overclocking

Taking a look at the base and boost clocks available for these cards, the RTX 2080 Ti is very much starting to show its age. The reported boost clock on the Founder's Edition is a mere 1,635MHz, lower than the 2080 Super's base clock of 1,650MHz. The 2080 Ti has pretty good headroom for manual overclocking, but the speed still isn't going to get as high as the Super, which can comfortably eke out an additional 5–10 percent of memory speed in the hands of a skilled overclocker.

The Radeon VII is a bit of a slouch here. While the boost clock of 1,750MHz is respectable, squeezing more than 5 percent of improved performance from this card is a struggle. The high temperature limits on this card do help a bit, but unfortunately the limits of the current 7nm FinFET architecture are plain to see. The 2080 Super is easily capable of breaching 2,000MHz when overclocked, which can partially make up for the lower baseline performance when compared to the 2080 Ti. It's not going to reach the same heights as the more expensive card, but it's got just as much headroom for manual overclocking, if not more, and also has a greater improvement between base and boost clocks: an increase of 165MHz as opposed to the 2080 Ti's 120MHz.

Winner: RTX 2080 Super

AMD
RTX 2080 Super
RTX 2080Ti

From left to right: **AMD kicked off 7nm architecture with the Radeon VII, later using it for the RX 5700 series.**

The RTX 2080 Super is the baby of this group, released just a few short months ago.

The 2080 Ti remains a mark of status among PC gamers.

© AMD, NVIDIA

ROUND 4

Performance

Watch out, here comes another spoiler—though we hope you saw this one coming. The RTX 2080 Ti obliterates the other cards when it comes to performance, arguably the most viable option for 4K ultra gaming right now. The other cards effectively demand a sacrifice of either frame rate or graphical fidelity when running games at 4K—even the Ti struggles with some games, though. The 2080 Super does its level best to keep up, and performs admirably considering it costs more than a third less than its older brother. It's also worth noting that both are equipped with ray-tracing tech, which the AMD card lacks; indeed, the 2080 Ti and 2080 Super are practically the only GPUs suitable for ray tracing at high graphical levels right now.

Sadly, the Radeon VII falls behind. While many hoped it would be a GeForce-killer, no ray tracing and lackluster frame rates killed that dream. However, it's worth noting that the VII excels in other areas: 16GB of VRAM, 2GT/s of memory speed, and a stonking terabyte/s of memory bandwidth mean it's a powerhouse when it comes to 3D rendering and video editing. We're looking at 4K gaming here, but it's a solid workhorse GPU that doesn't bite your wallet as badly as Nvidia's high-end cards, such as the Quadro and the Tesla.

	RTX 2080 Super	RTX 2080 Ti	Radeon VII
Tom Clancy's The Division 2 (fps)	47/40	**59/50**	39/33
Assassin's Creed Odyssey (fps)	43/35	**53/40**	37/27
Far Cry 5 (fps)	62/53	**78/64**	58/46
Shadow of the Tomb Raider (fps)	52/43	**62/50**	46/35
Middle Earth: Shadow of War (fps)	57/44	**72/56**	49/38
Metro Exodus (fps)	46/30	**57/37**	42/27
Total War: Warhammer II (fps)	59/47	**72/57**	43/32

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung 970 Evo M.2. All games are tested at their highest graphical profile with AA turned on at 4K. Figures provided are an average and a minimum (97th percentile) respectively.

Winner: RTX 2080 Ti

And the Winner Is...

The Radeon VII! No, just kidding, although we don't want to discredit AMD's top-tier GPU, particularly if you use your system primarily for content creation. The real winner is the GeForce RTX 2080 Super. It was a close call, but we've got to give it to the newer card; it's simply better value, and provides sufficient performance to hold its ground at 4K without breaking the bank. Ray tracing and the improved TU104 architecture only sweeten the deal.

When it comes down to it, the main reason to buy an RTX 2080 Ti is because it's the best commercially available GPU around. If you've got an urgent need to have the absolute best of the best, sure, it's a great card. But twin-fan models of the 2080 Super are available for scarcely more than $700, and it'll run most games at a respectable frame rate in 4K—more so if you're willing to drop from ultra to high settings. For $400 dollars less, it's hard not to admit that the Super is just that: a super alternative to pricier 4K options.

And lastly, yes, we're aware that the Titan RTX exists. Despite ostensibly being the best gaming GPU on the market, it would lose every category except performance, and the insane price tag means we'd never recommend it for mere 4K gaming. Please don't come after us on Twitter for doling out some hard truths.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

- > Simple Speed Boost
- > Smooth Windows
- > Intel Security

Fuss-Free Overclock

I just purchased an EVGA GeForce RTX 2080 SUPER XC Gaming and need your help auto-overclocking it, as I'm a newb. Is EVGA Precision X1 or MSI Afterburner better to use? What, if any, settings should I apply to either program before running it for the auto-overclock?

–Keith Brooks

THE DOCTOR RESPONDS: We'll skip the usual disclaimers about overclocking, as we're sure you know what the dangers versus benefits are. Ensure your PC—including your GPU drivers—is up to date, then download MSI's Afterburner tool (www.msi.com/page/afterburner), which has the required OC Scanner for automatically determining a stable overclock for your RTX 20-series card, wrapped up in a user-friendly front end that makes it easy to compare your GPU's performance pre- and post-overclock.

Launch Afterburner, then click the "Settings" button. Check both "Unlock voltage control" and "Unlock voltage monitoring," click "OK," then whack up "Core Voltage," "Power Limit," and "Temp Limit" to their maximum using the sliders. Open the Voltage/Frequency curve editor using the bar chart button to the left of "Core clock," then click "OC Scanner" in the top-right, followed by "Scan." Wait 15 minutes or so while it determines the highest stable frequencies for an overclock. After completion, verify the "Core Clock" value now shows "Curve" instead of a number, then click "Test" to verify the overclock is stable. If the score is to your liking—60 percent or greater seems to be acceptable—click "Apply" to make the OC permanent. We also suggest clicking the floppy disk icon to save these figures as a profile—you can then switch between these and your default settings using the "reset" button.

Rein My PC In

My problem is that despite hardware supercharging year after year, my PCs have less "snap" than ever. I seem to constantly chase my tail trying to find out why my PC is so slow. I end up in Safe mode 10 times a year hunting the cause. Task Manager reveals 46 background processes, and there's no way to determine which way is up or down.

I need a hands-on service to keep my PC tuned. I've asked in several forums and they tell me how bad PC maintenance software is. As a retiree, I'd like to browse out the rest of my PC time, unencumbered by Safe mode expeditions. There must be services out there to subscribe to...

–Michael McLaughlin

THE DOCTOR RESPONDS: There is one constant in the PC world: system degradation. Even the most carefully cultivated Windows installation slows down over time until you reinstall from scratch. That said, you should enjoy decent system performance for years before you have to rip everything up.

The rapid speed of hardware evolution has meant modern programmers don't need to be too efficient when it comes to keeping code tight and optimized, so you can't avoid the passage of time forever. When upgrading, focus on three key areas to keep your PC running as smoothly as possible: a multi-core CPU, lots of RAM (aim for 16–32GB), and a fast boot drive (SSD or, preferably, PCIe NVME).

We agree that PC maintenance software isn't worth the time or effort—don't get us started on the havoc registry cleaners can wreak, for example. Rather than put your trust in a third party, why not invest your time in a handful of tools to stay on top of things? First, utilize some form of rollback software to prevent detritus building up. One approach is a drive-image tool such as the Doc's favorite, Macrium Reflect Free (www.macrium.com/reflectfree.aspx). However, if you frequently install apps for testing purposes, and then ditch them, go for something that enables you to roll back instantly—Rollback RX Home (https://horizondatasys.com/rollback-rx-time-machine/rollback-rx-home/) is one such example.

Other tools to consider: BootRacer (www.greatis.com/bootracer) is the perfect tool for monitoring startup times, while Autoruns (https://bit.ly/autoruns) lets you control what starts with your PC. Finally, if your PC is still struggling with occasional rogue processes bringing things grinding to a halt, Process Lasso (https://bitsum.com) will rein them in.

Are Intel CPUs Secure?

I'm shopping for a new mobo/CPU, GPU, and 32GB

↘ submit your questions to: doctor@maximumpc.com

RAM. I don't play a huge number of games and want to run at least three monitors. It needs to be fast and reliable. I've always bought Intel, but am now seeing mentions of Intel CPU security flaws. I still want Intel—I've been thinking about the i9-9900K—but is there anything to worry about security-wise? **–Larry**

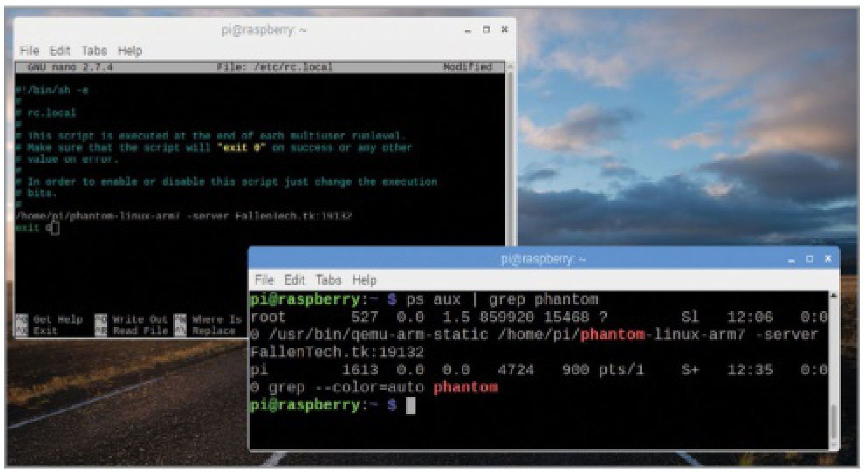
THE DOCTOR RESPONDS: All Intel chips—including the latest 9th-gen line—suffer from the same vulnerabilities collectively referred to as Spectre and Meltdown. The biggest difference between the 9xxx line and 8xxx line is that some of the patches designed to fix these holes have been implemented at the hardware level—in other words, they're on the chip, so don't require a microcode update distributed via BIOS or OS updates.

This means the i9-9900k suffers from the same issues as previous generations, but the holes have been patched. The Doc reckons you're safe enough with this chip, but if you're still squeamish, the closest AMD equivalent is the Ryzen 9 3900X, which even outperforms the i9-9900K in several benchmarks. Pair it with an X570 board like the ASRock X570 Taichi (see Oct 2019 issue, pg. 83).

If you're looking for a cost-effective GPU to power three or more monitors, we recommend the Zotac Gaming GeForce GTX 1660 6GB, which boasts three DisplayPorts and one HDMI port, all of which can be used simultaneously.

Restore Aero Glass

I'm getting ready to update both my and three friends' computers to Windows 10, and was wondering if the mods in Nick Peers' article "60 Ways to Customize Windows" (Sept 2019 issue) need to be reinstalled when Windows 10 does a major update—in particular, Ultimate Windows Tweaker, Winaero Tweaker, and Aero Glass for Windows 8. **–John Hau**



```
 GNU nano 2.7.4            File: /etc/rc.local              Modified

#!/bin/sh -e
#
# rc.local
#
# This script is executed at the end of each multiuser runlevel.
# Make sure that the script will "exit 0" on success or any other
# value on error.
#
# In order to enable or disable this script just change the execution
# bits.
#
/home/pi/phantom-linux-arm7 -server FallenTech.tk:19132
exit 0

^G Get Help   ^O Write Out  ^W Where Is
^X Exit       ^R Read File  ^\ Replace
```

```
pi@raspberry:~ $ ps aux | grep phantom
root       527  0.0  1.5 859920 15468 ?        Sl   12:06   0:0
0 /usr/bin/qemu-arm-static /home/pi/phantom-linux-arm7 -server
FallenTech.tk:19132
pi        1613  0.0  0.0   4724   900 pts/1    S+   12:35   0:0
0 grep --color=auto phantom
pi@raspberry:~ $
```

Connect Xboxes to remote *Minecraft* servers with the help of Phantom.

THE DOCTOR RESPONDS: If you were upgrading from one Windows 10 build to another, the likelihood is at least some of your tweaks would stay in place (but not all, because often these tweak tools restore deprecated features that are removed from future builds). That's the case with the tweaks offered by UWT and Winaero Tweaker—open both tools after upgrading and verify which settings have been kept and which ones need reapplying again.

In the case of Aero Glass, it will stop working after the upgrade. You'll need to download and install the latest version of Aero Glass for Win 8.1+ from https://glass8.eu/download, which is compatible with all builds of Windows 10 up to 1903. We wonder why Nick wasn't able to get it to work—the Doc had it up and running first time, although it did throw up a compatibility error (while still working). Download, unzip (use 7-Zip from www.7-zip.org), and run the "Testing version of GUI application" from the same link to tweak its settings—the 100 percent transparency on the title bars renders them almost invisible.

Serving Minecraft

I know: *Minecraft?* I've been a gamer since the early 1980s, and my kids played *Minecraft* when it first came out. This summer, I finally tried it for myself and surprisingly liked it. My kids—all now young adults—still play, but many of them are only on Xbox. I was searching on the Internet for a way to connect an Xbox to a remote PC *Minecraft* (bedrock) server and found a solution on YouTube that requires a PC to be set up on the same LAN as each Xbox so it can connect to remote *Minecraft* servers.

So, simple question: What's the minimum (i.e., least expensive) build and OS that I would need? It must be always-on and would be nice to set it up to automatically reboot and restart the program (Phantom) after a power loss. Thanks for your wisdom. **–Thomas Eddy**

THE DOCTOR RESPONDS: The solution you've uncovered—Phantom (https://github.com/jhead/phantom/releases)—is designed to act purely as a proxy to allow Xboxes on remote networks to connect to each other through a single server of your choice (which can be a Microsoft-hosted service or a custom-built server on your own PC). That means you need to distribute one Phantom proxy to each family member who needs it. The good news is that not only does Phantom support Windows, Mac, and Linux, but there are also builds for the Raspberry Pi. You should be able to run it merrily on a Pi 3 (around $50, including case and PSU), but it'll run on any older laptop or desktop, too.

The following covers setting up Phantom on a Raspberry Pi. Once the basics are installed and configured (use the Terminal in Raspbian or simply install Raspbian Lite for exclusive command-line usage), you must issue the following commands:

```
$ wget https://github.com/jhead/phantom/releases/download/v0.2.0/phantom-linux-arm7
$ chmod u+x ./phantom-linux-arm7
```

Technically, you can now manually run the proxy using the following command:

```
$ ./phantom-linux-arm7 -server FallenTech.tk:19132
```

Obviously, substitute "FallenTech.tk" with your choice of server (see https://minecraftpocket-servers.com for inspiration). You should see confirmation that the proxy connection has been made, and it'll hold until you close the Terminal window.

What you want, of course, is something that will run in the background and respawn automatically on a reboot. There are several ways to do this—the simplest is to edit the "rc.local" file:

```
$ sudo nano /etc/rc.local
```

Remove everything between "#Print the IP address" and "exit 0" lines, then insert the following line in their place, above "exit 0":

```
home/pi/phantom-linux-arm7 -server FallenTech.tk:19132
```

Press Ctrl-X, then press Y followed by Enter to save your modified "rc.local" file. Next, you need to make the "rc.local" file executable, so it starts on bootup:

```
$ sudo chmod a+x /etc/rc.local
```

Reboot your Pi and that's it—to verify the proxy is running, open another Terminal window and issue this command:

```
$ ps aux | grep phantom
```

If it's running, you should see an entry for "phantom-linux-arm7" assigned to root, indicating it's ready to act as a proxy server for the Xboxes on your local network. You can now unplug it from monitor, keyboard, and mouse, and leave it to its own devices. To administer it remotely, use "sudo raspi-config" and go to "Interfacing Options," selecting "SSH" and choosing "Yes → OK → Finish." ⏻

$500 BUILD IT CHALLENGE

Can we build the best upgradable system for under half a grand?

BY CHRISTIAN GUYTON

WE'RE BACK with another featured build, and this time our focus is customizability. We wanted to make a straightforward, versatile system to act as a launchpad for future expansions. As such, we had a budget to work with: $500. And we stuck to it (sort of). We decided early on that integrated graphics would be the way to go; we've got the space to add a dedicated GPU (or any other expansion cards that strike our fancy) later, if we want.

Flexibility is king here, but our system needed to be a capable PC in its own right, too. A mix of old and new components proved to be the cocktail we needed to create the perfect system for this task, although we'll look back at the end and see whether there's anything we could have done better. We'll also be taking some time to break down the directions in which this system could be upgraded, whether it's to become a high-powered gaming rig or a music-editing system.

That placed a few caveats upon us. First off, we needed a motherboard that was ready for upgrading; that meant plenty of DIMMs and PCIe slots, along with M.2 support, and the ability to take new Ryzen CPUs. We're going with AMD rather than Intel for our processor, due to the availability of newer AMD chips with integrated graphics. We also needed a PSU capable of handling those extras, and a case with room for more drives.

We're using a current-gen Ryzen processor with a last-gen motherboard, which might have you worrying about compatibility issues. Have no fear—we can rectify this with a few simple BIOS updates. This is where it gets complicated, though. X470-series motherboards can support either first-gen and second-gen Ryzen chips, or second-gen and third-gen, but never all three at once. Assuming your X470 board didn't come with the latest BIOS updates installed, you need a 2000-series Ryzen CPU and a USB flash drive. Consider these add-ons to the build that we won't be mentioning in the ingredients list—they won't be used in the finished build, but you need them to get the system up and running.

INGREDIENTS

PART		PRICE
Case	**Cooler Master MasterBox Q500L**	**$57**
Motherboard	**Gigabyte X470 Aorus Ultra Gaming**	**$125**
CPU	**AMD Ryzen 3 3200G**	**$95**
CPU Cooler	**AMD Wraith Stealth**	**$N/A**
Memory	**16GB** (2x 8GB) **Corsair Vengeance LPX DDR4-2666**	**$59**
PSU	**450W Corsair CX450 80+ Bronze**	**$50**
Boot Drive	**500GB Crucial MX500 SSD**	**$64**
Storage Drive	**1TB Western Digital Blue HDD**	**$40**
OS	**Windows 10 Home**	**$100**
Total		**$590**

PRICES CORRECT AT TIME OF PRINTING.

AMD
AMD
AMD Ryzen 3 3200G
AMD
RYZEN
© 2016 AMD

CPU COOLER

AMD WRAITH STEALTH $0

IT'S FREE! That's all we have to say about this. Just kidding—the Wraith Stealth cooler that comes packaged with the Ryzen 3 3200G at no extra cost is actually a really good little cooling solution. It's simple to install, has a low profile that will fit in just about any case, and easily provides the cooling necessary for low-pressure computing with integrated graphics. It's still just air cooling, making it weaker for overclocking purposes, but we're not going to be overclocking this build anyway. The Q500L case has room for a small AIO cooler if we decide to upgrade, too.

CPU

AMD RYZEN 3 3200G $95

THE CHEAPEST CHIP in the Ryzen 3000 range, this comes with four cores, a base clock of 3.6GHz, and its own cooler (see above). Most importantly, it's got the integrated graphics—Radeon Vega 8—that will power this rig. AMD claims this CPU can hit 4.0GHz in overclocking, but we've got reservations, especially as we're only using the stock cooler. That's OK—we've got no plans to overclock this build, and at less than $100, this is exactly what we need.

RAM

CORSAIR VENGEANCE LPX 16GB (2x 8GB) DDR4-2666 $59

WE CAN STOP SINGING the praises of Corsair's excellent Vengeance LPX line whenever we want, honest, but we just don't want to. It might not be as flashy or as fast as other memory—with no LEDs and a simple black metal finish—but this kit will serve us well. We contemplated a gentler 8GB, but 16GB for less than $60 was too good an offer to pass up. The 3200G does benefit from fast memory, but we want value for money, so we've opted for a 2,666MHz kit of two 8GB DIMMs. Simple, but effective.

VENGEANCE
LPX
VENGEANCE
LPX
DDR4

MOTHERBOARD

GIGABYTE X470 AORUS ULTRA GAMING $125

NO, WE'RE NOT USING an X570 board, even though we are using a third-gen Ryzen. The new AMD-compatible motherboards are still prohibitively expensive, so we've opted for a cheaper X470 one. Gigabyte's Aorus Ultra Gaming has everything we need, and leaves lots of space for upgrading. We've got room for more drives, a more powerful CPU, more memory, and any sort of PCIe expansion, be that a GPU, soundcard, or something else entirely. With no other flashy lighting around, this will be the only source of RGB effects inside our case—it's going to be a muted affair.

AORUS
X470 AORUS ULTRA GAMING
GIGABYTE
AMP-UP AUDIO

UPGRADE & IMPROVE PG. 36

UPGRADE & IMPROVE PG. 36

SSD

CRUCIAL MX500 500GB $64

CRUCIAL ALWAYS HAS it covered when it comes to SSDs. This time around, we're using its MX500, giving us half a terabyte of SATA storage to play with. This will be our boot drive, containing the OS and immediate file storage. We did look into using a smaller M.2 SSD for our primary drive, but even the launch of NVMe Gen4 hasn't lowered the prices of older M.2 drives enough for this low-cost build, so we're sticking with SATA for now. 500GB isn't quite enough for a full system, though, so we've enlisted some backup....

HDD

WESTERN DIGITAL BLUE 1TB $40

...AND HERE IT IS. Western Digital's HDDs are still some of the best in the business, running quietly and not drawing too much power from your build. A terabyte of storage for just 40 dollars is a steal, too; a far cry from the pricey, bulky drives of yesteryear. The Q500L can support up to four SATA SSDs or two HDDs, so we've still got room for one more SSD on those drive brackets, should we decide to upgrade—alternatively, there's plenty of space on the motherboard for a speedy M.2 drive.

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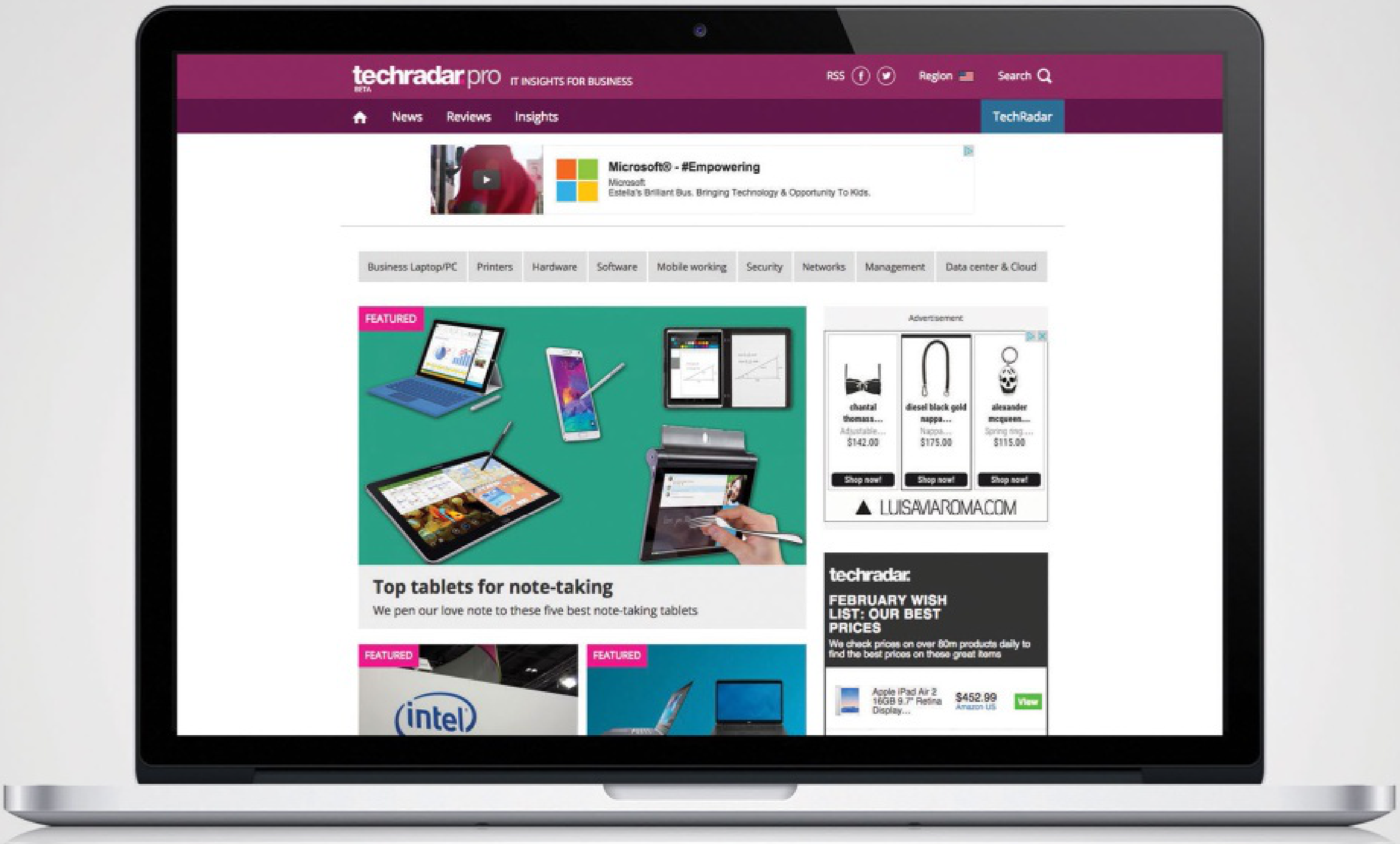
IT INSIGHTS FOR BUSINESS



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PSU

450W CORSAIR CX450 80+ BRONZE

$50

POWER SUPPLY PRICES are in constant flux, so this part of the build is nebulous at best. Really, we just recommend using whatever 140mm PSU you have to hand or can get cheaply online. We're using Corsair's CX450, as it's a good little power brick that comfortably provides all the wattage this system will need; anything in excess of 500W would be overkill. The CX450's low price means that it isn't modular, which will leave us with some excess cabling to deal with, but that's not the end of the world. If you do happen to have a modular power supply, go right ahead and use that instead for a slightly tidier build.

CORSAIR
CX450

UPGRADE & IMPROVE PG. 36

CASE

COOLER MASTER MASTERBOX Q500L

$57

WE REVIEWED THIS CASE a little while back, and opinions were mixed. It's almost TARDIS-like in its complexity, seeming capable of fitting more inside its little metal frame that should logically be possible. The customization options will be seen as a boon to some and utterly pointless to others. Yes, you can unscrew and remount the front I/O toward the rear of the case. Why would you? Well, that's not a question for us to answer, because we're not doing that. What we are doing, however, is nodding with satisfaction that we picked one up for a mere $57 online. Good job, us.

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READY TO BUILD

ONCE YOU'VE GOT ALL OF YOUR COMPONENTS READY, FOLLOW OUR STEP-BY-STEP GUIDE TO ASSEMBLE THIS VERSATILE $500 PC

01 PREPARE FOR BATTLE

OUR PREPARATION TIME is going to be a little more detailed this time around. All the usual rules apply: Make sure you've got a nice open surface to build on, a small bowl or other container to keep loose screws in, and all the tools you're going to require for this build (namely a Phillips head screwdriver, cable ties, and some thermal paste). There's one more thing to consider, though: You're going to have to set up the motherboard outside the case, so the BIOS can be updated before we assemble the system. Slot in your chosen Ryzen 2000 processor by lifting up the metal retention arm and dropping it into place before resecuring it, then fit a stock cooler. You'll also want to put any sticks of RAM on the board now, to prevent potential issues with booting the BIOS. With that done, you can place the motherboard on a heat-resistant surface and connect it to the power supply. Turn it on, and make sure you can reach the BIOS screen. You shouldn't need a drive attached at this stage—as long as you can access the BIOS, you'll be able to do everything you need to do to update the mobo's compatibility.

02 FLASH AND THUNDER

THE GIGABYTE X470 Aorus Ultra Gaming needs three BIOS updates. On a different PC, go to www.gigabyte.com, locate the mobo's support page, then scroll to the BIOS updates, starting at F2 and ending at F42d. Head into the BIOS and check your version. If the board is new, it should be F1. We're leaping to F31, followed by F40, then F41. If you've got F31 or F40, you can jump ahead. Download the file, unzip it, and slap it on a flash drive. Plug it into the X470 board, select "Q-Flash" in the BIOS, then "Update," and locate the file on the flash drive. Once updated, restart, then repeat the process for F40, then F41. F42d primarily just fixes AMD compatibility issues for Destiny 2, and Gigabyte advises against it unless necessary. Once F41 is installed, swap out the CPU to the Ryzen 3 3200G, and check the BIOS acknowledges it. If it does, unplug everything and move on.

03

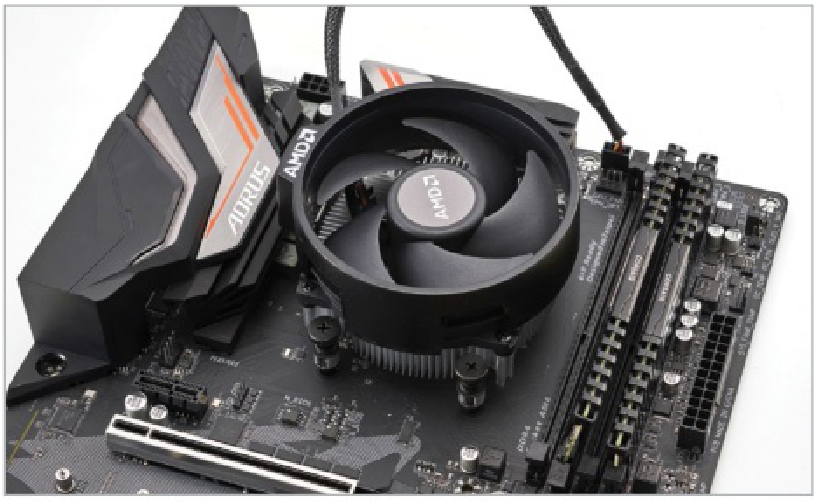
OPEN 'ER UP

THE MASTERBOX Q500L is something of a strange beast in the world of computer cases, with its removable front I/O, vertical PSU mounting bracket, and feed-through power cable. The I/O can be switched to different sides of the case, but we're going to be leaving it in the default position for this build; therefore, when you strip down this case to get ready to build, just leave the I/O in place, and tuck the cables out of the way. The PSU bracket, however, can come out—remove the magnetic dust filters from the case, detach both side panels, then unscrew the bracket from the perforated metal frame of the case. Set the bracket aside for now—we'll be needing it later on. There's not much else that has to be done at this stage; leave the case fan cable tied up (it gets in the way of the mobo installation otherwise), and remove the drive mounts behind the motherboard plates, setting them both aside for later, too. We are ready to start building!

04

COPY PASTE

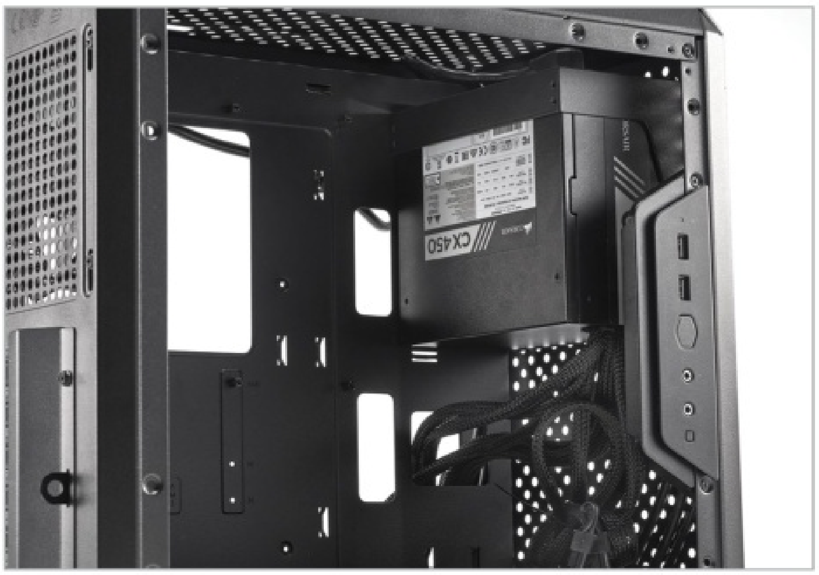
SET THE CASE ASIDE, and get the motherboard ready to go. Unless you have an antistatic work surface, use the box the X470 came in as a workbench. Your processor should already be in place, so grab the Wraith Stealth cooler that came with it—be careful when removing it from the box, as there's a layer of thermal paste on the bottom. Make sure the correct AMD bracket is fitted to the underside of the mobo, then screw down the cooler on top of the CPU, making sure all four screws are tight. Next, pop open the clasps on the second and fourth DIMM slots heading away from the CPU socket (labeled DDR4_1 and DDR4_2), and insert the Corsair Vengeance LPX memory, pushing down on both ends until it clicks into place. If you installed the RAM earlier, give yourself a pat on the back. On to the next step!



05

MOUNTED AND LOADED

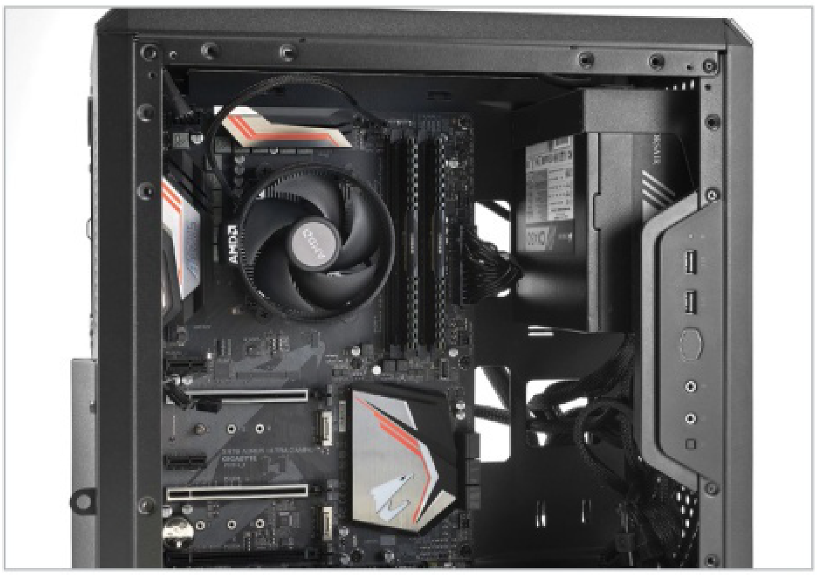
TAKE THE BRACKET you set aside, and screw the CX450 PSU into place, making sure the long side of the bracket is on the same side as the PSU fan. When the PSU is installed, the fan should face outward through the case's dust filters. For the actual installation, put the case on its side and line up the bracket in its original position. Before screwing it in, feed through the power extension cable, and plug it in. When it's time to screw the bracket in place, ensure it's lined up properly; there is a subtle line on the case exterior that shows where the PSU needs to line up. Take care not to damage the front I/O's cable connectors—remember that the I/O can be removed and put back once the PSU is in place.



06

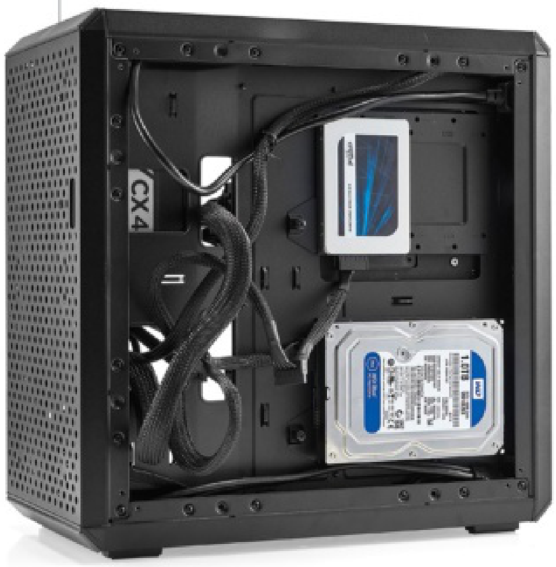
A TIGHT FIT

THE MASTERBOX Q500L has an unusually pronounced bezel around the window panel, which, combined with the bulky PSU bracket, leaves only a narrow space to slide in the motherboard (don't forget to fit the rear I/O shield to the case first). We found the best option was to insert it diagonally, rotating it as you go. Fitting it under the rear case fan is also a struggle, as there's little room to maneuver. Once it's inside, fit it on to the central mounting peg, and screw it down to the nine standoffs, first double-checking that the rear I/O is lined up correctly. Once done, connect the motherboard and CPU power cables by feeding them behind the mobo, then back out of the closest hole in the mounting plate.



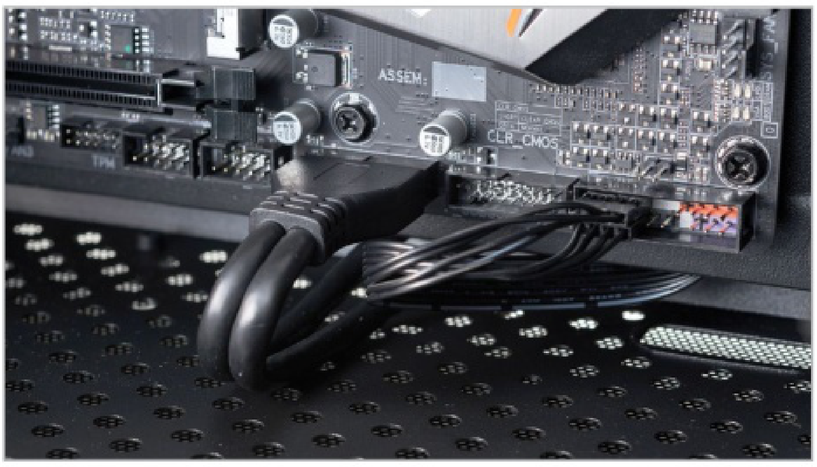
07 DRIVE BY

THIS SECTION is mercifully quite simple. Take the two drive mounting brackets from the case, and screw the Western Digital HDD to one, and the Crucial SSD to the other. They will be mounted at right angles; the HDD should face to the left once installed, while the SSD will face downward. Due to the PSU placement, this case is a bit top-heavy, so we fitted the HDD to the lower bracket with the SSD above it, but you can align them the other way around if you like. Reinstall both brackets to the case by slotting them in on the right-hand side, then securing the thumbscrew on the left. Simple! We'll get ahead of the game with cabling here, too. Connect the accessory cables from the power supplies—you need two, as the Corsair CX450's multi-connector cables won't reach far enough—then plug in the SATA connectors and feed them to the far-left of the case, before bending them around the edge of the mobo plate, and connecting them to the board in slots 0 and 2 (labeled on the board), making sure the SSD is in slot 0, because it will be our boot drive.



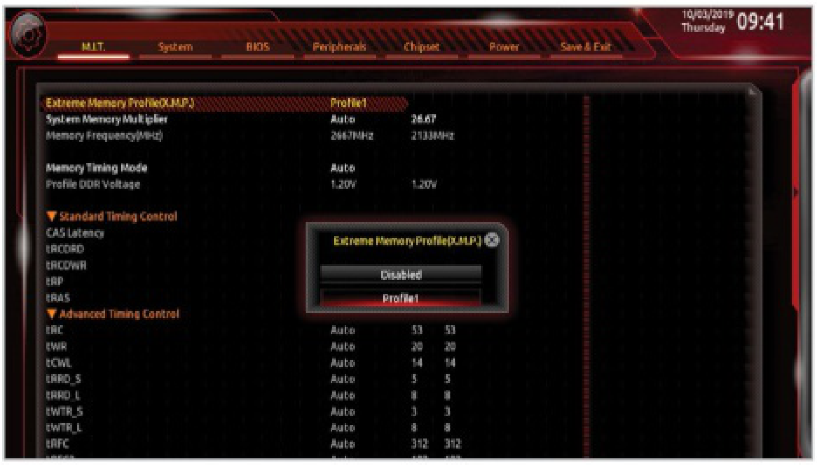
08 MIDDLE MANAGEMENT

WITH ALL OUR components set up, this build needs some tidying. The first stage is to separate the unused cables from the PSU, neatly bundle them together, secure them with a cable tie, and tuck them behind the front I/O. The Q500L is a good case, but it lacks space for concealing surplus cables. With no PSU shroud and minimal cable routing space behind the motherboard, we'll have to settle for tying up our loose cables like this. Leave the front I/O cables loose; the USB and HD audio cables need to be threaded along the bottom of the case behind the motherboard plate, then brought through to be plugged in. As for the tiny front I/O control connectors, we found it best to plug them in directly, then draw back the slack, and tie it up with the rest of the bundled power cables. There are plenty of clips on the rear of the mobo plate for you to secure cables back there.



09 MEMORY SETUP

BACK INTO THE BIOS we go. We're going to get everything set up here now the system is built. Get the system plugged into your display and enter the BIOS. Our first step is to restore the default optimized settings; you can do this with a simple click on the BIOS's exit page. If you bought your board second-hand, this step is vital; otherwise, it's still worth doing to clear out any possible niggles. Next, we need to check our memory is running at speed. It should be active at 2,666MHz; it might manage to hit this by itself, but if not, switch on the XMP profile under memory control. You can check the operating speed outside of the BIOS using a system monitoring program, such as CPUID. Lastly, check the boot priorities; both of your drives should be blank at this stage, but make sure that the Crucial SSD is at the top of the boot priority list.



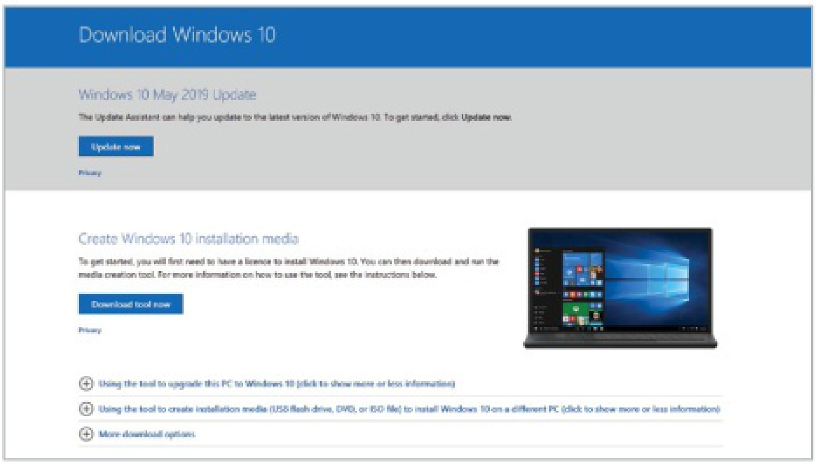
```
Extreme Memory Profile(X.M.P.)   Profile1
System Memory Multiplier         Auto       26.67
Memory Frequency(MHz)            2667MHz    2133MHz

Memory Timing Mode               Auto
Profile DDR Voltage              1.20V      1.20V

▼ Standard Timing Control
CAS Latency
tRCDRD
tRCDWR
tRP
tRAS
▼ Advanced Timing Control
tRC                              Auto       53    53
tWR                              Auto       20    20
tCWL                             Auto       14    14
tRRD_S                           Auto       5     5
tRRD_L                           Auto       8     8
tWTR_S                           Auto       3     3
tWTR_L                           Auto       8     8
tRFC                             Auto       312   312
```

10 INSTALL WINDOWS

YOU NEED your copy of Windows 10 on a USB drive, as this system doesn't have a DVD drive (unless you have one lying around). It's a fairly simple process: Plug in the USB drive, fire up the system, and follow the installation instructions. Make sure the OS is installed on the MX500 SSD, and delete any partitions on either drive. We recommend going with custom rather than express installation, and turn off any features you don't want to engage in your version of Windows, such as Cortana's personal assistant settings, or personalized ad data. Once installed, make sure it boots properly, and check that the HDD is also accessible in the file explorer. If you're serious about performance, now is the time to stress-test your build with benchmarking software such as Prime95 or Cinebench. Otherwise, this build is complete, so let's take a look at the numbers….



Download Windows 10

Windows 10 May 2019 Update

The Update Assistant can help you update to the latest version of Windows 10. To get started, click **Update now**.

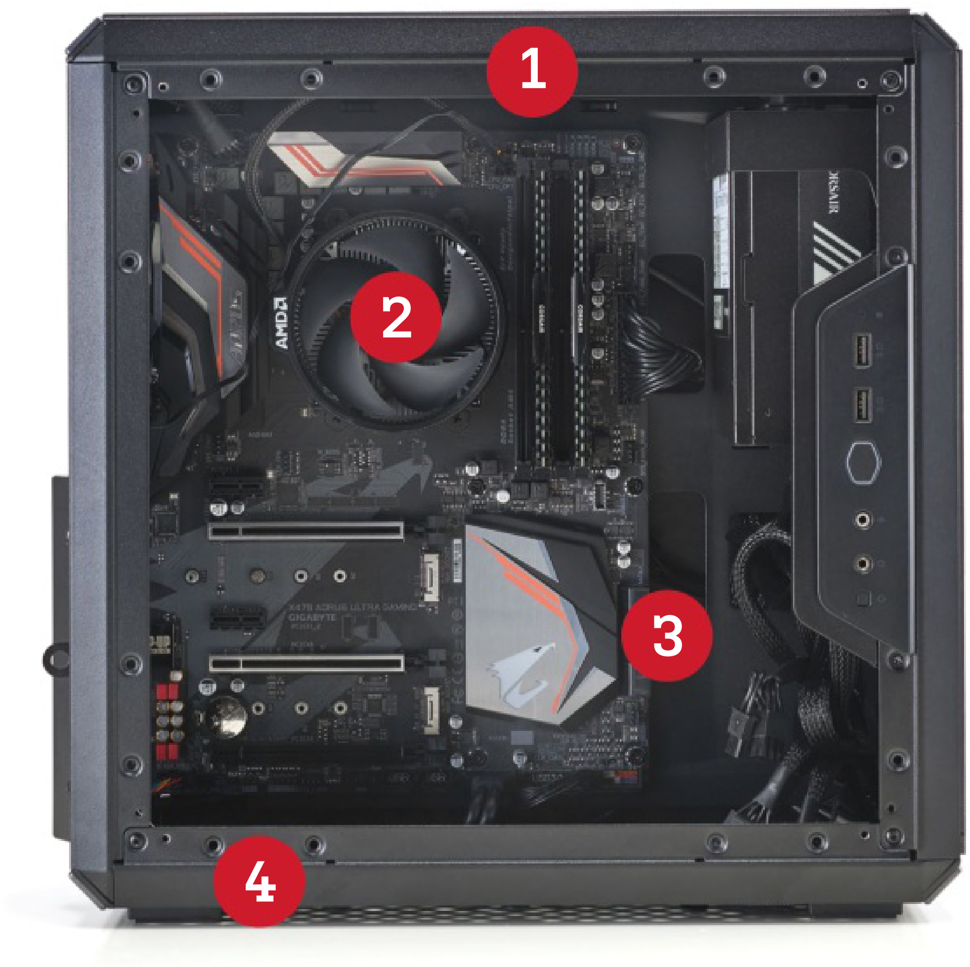
Create Windows 10 installation media

To get started, you will first need to have a licence to install Windows 10. You can then download and run the media creation tool. For more information on how to use the tool, see the instructions below.

⊕ Using the tool to upgrade this PC to Windows 10 (click to show more or less information)

⊕ Using the tool to create installation media (USB flash drive, DVD, or ISO file) to install Windows 10 on a different PC (click to show more or less information)

⊕ More download options



1 We stuck with the single case fan that comes with the MasterBox Q500L, but there's ample space on the top and bottom of the case for additional fans.

2 The Wraith Stealth is the smallest of AMD's stock CPU coolers, but it gets the job done in a low-cost system like this.

3 There's precious little space for cable management inside this case, but thankfully the front I/O can be used to hide away some of the excess cables.

4 The feet of the Q500L can be popped out and reattached to any side of the case for custom orientations. Want your rear I/O on the top of your system? You're weird, but this case has you covered.

WITHOUT WINDOWS 10, this build would cost $490, which we're pretty happy about. The 3200G performed above expectations; in fact, we'd say it's the best-value CPU with integrated graphics on the market. Under $100 for performance that can comfortably carry out normal work functions and even cope with light gaming strikes us as an excellent deal. We managed to get an average of 30fps in *Rise of the Tomb Raider* by running it at low graphical settings in 1080p; less demanding titles such as *Fortnite* or 2D indie games run smoothly in 1080p.

There are a few things we'd do differently. When it comes to components, turn the page to see which parts we suggest upgrading. There were some challenges in the build process, too; using an ATX mobo was a tall order, as the Q500L case has an enormous lip around the internal edges once the window panel is removed. Were we to build it again, we'd consider installing the memory and cooler after the mobo is mounted, as they add to the weight during installation, which makes things trickier. On the other hand, installing components inside this already cramped case would be harder than doing so outside—it's a trade-off, with no simple answer.

The complications caused by the case, BIOS, and cable management meant that it took us longer than expected to fully assemble. The latter was a particular point of contention; the Corsair CX450 power supply had a large number of leftover cables to tidy up. A modular PSU is the obvious answer, but that would have added too much to our total price, and doesn't solve the problem of excess cable lengths. Again, there's no easy solution; a bit more time spent routing cables will improve things, though, along with liberal use of cable ties. If you can get your hands on shorter SATA connector cables for the two drives, that'll help, too.

This system was conceptualized as a blank canvas, from which it can be shaped into whatever machine suits your needs. We think we've succeeded in creating such a PC; the potential here for this build be upgraded and adapted to fulfill different purposes is significant. This system has two unused DIMMs, three unused PCIe x16 slots, two unused M.2 ports, and more. There's also room for more case fans, or a radiator for an AIO CPU cooler, and comfortable headroom for a larger air cooler on the CPU. This case can also be reconfigured to lay on its side, should you want to slot the finished PC into a space with minimal height clearance. In short, there's nothing this system can't do; what direction you take it is up to you.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	541	598 (11%)
CrystalDisk QD32 Sequential Read (MB/s)	540	562 (4%)
CrystalDisk QD32 Sequential Write (MB/s)	372	521 (40%)
Rise of the Tomb Raider (fps)	5	15 (200%)
Total War: Warhammer II (fps)	3	10 (233%)
Tom Clancy's Ghost Recon Wildlands (fps)	2	9 (350%)
3DMark: Fire Strike (Index)	1,183	2,642 (123%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i3-8100, 8GB of Team Vulcan DDR4 @ 2,400, and a 120GB Kingston SSDNow UV400. All tests were performed at 1080p at the highest graphical profile.

UPGRADE & IMPROVE

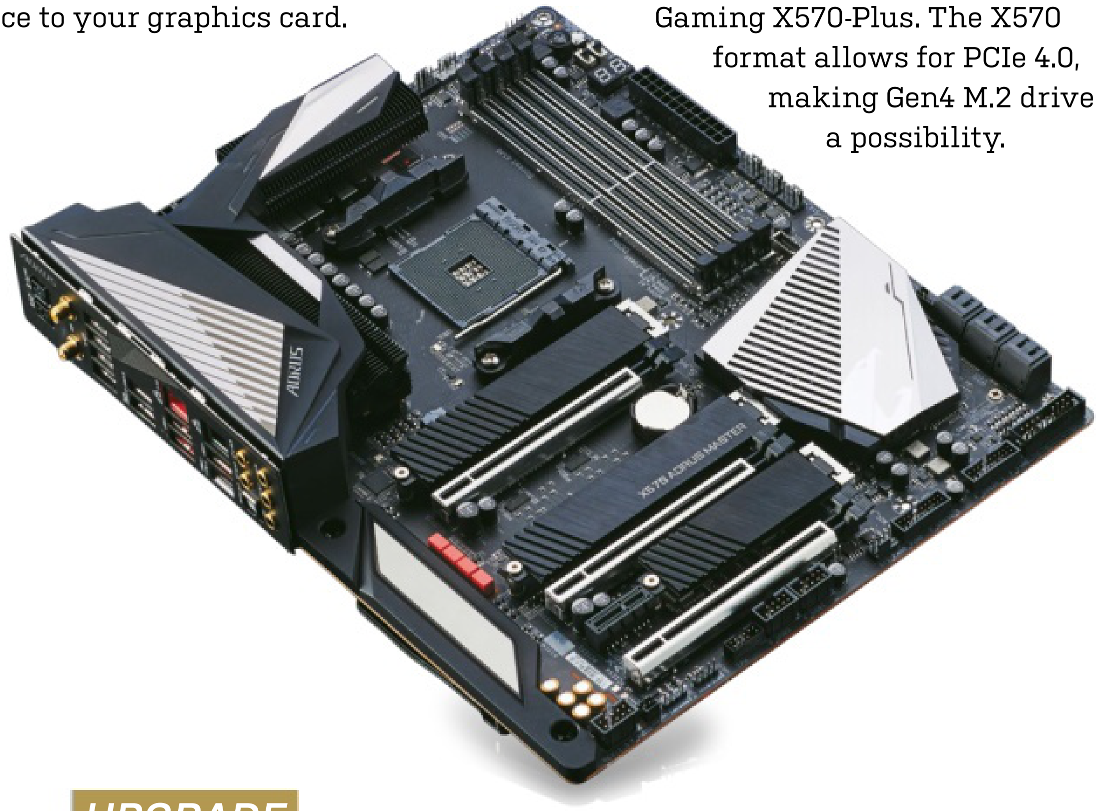
CPU

A SIMPLE UPGRADE for our CPU would be the **Ryzen 5 3400G**. At $50 more, it provides double the threads of the 3200G, and an operating frequency of 100MHz faster (200MHz at maximum auto-overclocking). The 3400G also uses Radeon Vega 11 integrated graphics, as opposed to the 3200G's Vega 8. However, if we were to add a discrete GPU, it might be worth investing in a more powerful CPU without integrated graphics, such as the Ryzen 5 3600 or Ryzen 7 3700X. As a rule of thumb, select a 3000-series Ryzen CPU comparable in price to your graphics card.

UPGRADE

MOTHERBOARD

THE MOST obvious upgrade here would be directly to an **X570 motherboard**, although, of course, this will come with an associated increase in cost. Cheaper X570 mobos start at around $150, although we would recommend upgrading to a slightly better model, such as MSI's MPG X570 Gaming Edge WiFi or Asus's TUF Gaming X570-Plus. The X570 format allows for PCIe 4.0, making Gen4 M.2 drives a possibility.



UPGRADE

PSU

THE LOGICAL CHOICE here is to go modular. The ability to simply remove unused power cables would work wonders for a cramped build like this, both in ease of assembly and in terms of aesthetics. There are plenty of good options, but our recommendation would likely be the **Corsair RM550x**, which provides fully modular power delivery for a little over a hundred bucks. Of course, if you're planning on throwing a GPU (or any other major components) into this build, you're going to need more power. 600W is perfectly sufficient for most systems that include a GPU, with 700W providing total peace of mind. Most importantly, make sure that the power supply you choose is small enough to comfortably fit the mounting bracket in the Q500L.

UPGRADE

STORAGE

THERE'S PLENTY to choose from when it comes to system storage, but one of the key things missing from this system is an M.2 drive, due to their significantly higher price compared to SATA SSDs. There's potential to improve our SATA storage here; a single extra 2.5-inch SSD could be added without needing to change anything else, or we could forgo the HDD and replace it with two more SSDs. 1.5TB of storage is already respectable, though, so more speed might be a better direction to look in. Team Group, Western Digital, and Patriot all produce affordable Gen3 M.2 SSDs, or if you're looking for a higher-quality piece, **Samsung** and XPG are the way to go. Remember that upgrading to an X570 motherboard will be necessary if you want to use a Gen4 M.2 drive.

UPGRADE

GPU

A GRAPHICS CARD would be the biggest key addition to this build. There's a myriad of potential options out there, but unless you're upgrading the CPU as well, it's best to stick with a relatively conservative choice. A **Radeon RX 580** or 570 from AMD would serve this build well, or a GeForce GTX 1650 from Nvidia. If you are inclined to upgrade the processor, though, the sky's the limit; currently, our top GPU recommendations are the GeForce RTX 2070 Super and 2080 Super, both excellent cards for 1080p and 1440p gaming. The Radeon RX 5700 XT also gets an honorable mention here, currently one of the best AMD GPUs available.

UPGRADE

MEMORY

16GB WAS GENEROUS for this build, which could run with 8GB or even 4GB. We stand by our decision, though; the increased capacity means this rig is better equipped to support CPU or GPU upgrades. There's still potential for expansion, mind you. Upgrading to 32GB would be overkill unless you completely overhaul this PC's internals, but as we're using an AMD CPU, improved memory speed will make a reasonable difference. An upgrade to Corsair's DDR4-3000 Vengeance LPX makes sense—G.Skill, **Ballistix,** and T-Force all have quality offerings in the 3000-3600MHz range, too.

UPGRADE

OTHER

OF COURSE, there are more esoteric components you could add. If music or video editing is your thing, a **soundcard** may be a worthy addition, or a capture card if streaming is what you plan to do. Additional case fans are a possibility, too, and potentially a valuable addition if you're looking to overclock anything. Lastly, we'll turn our eyes to aesthetics: lighting. The pronounced lip around the rim of the Q500L's mobo cavity is the perfect place to position sticky LED strips, and with the right screws, an RGB controller can be anchored to the inside of the case, thanks to the perforated metal design.

UPGRADE

COOLER

IN ALL HONESTY, the cooler is the last part of this build that needs upgrading. For low-intensity tasks, the Wraith Stealth provides all the heat management you'll need, and upgrading the CPU will provide you with another packaged AMD cooler (such as the Wraith Spire or Wraith Prism). If you're looking to go further, the Q500L can support up to 240mm of radiator space for an AIO cooler. **Cooler Master** has plenty of offerings in this arena, which are practically guaranteed to be compatible. Corsair and Enermax also have affordable AIO cooling solutions. Unless you're looking to overclock, 120mm of radiator space should be sufficient for most CPUs.

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THE HISTORY OF THE PC

In a world of competing processors and operating systems, *John Knight* explores how the PC began

THE PC. The personal computer. The IBM-compatible. Whatever you want to call it, somehow this machine has maintained a dominant presence for nearly four decades.

If you try to launch a program from the '80s to the 2000s, you have a good chance of getting it to launch—your PC has backward compatibility going right back to the '70s, enabling you to run pieces of history as though they were from yesterday. In fact, your computer is brimming with heritage, from the

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way your motherboard is laid out to the size of your drive bays to the layout of your keyboard.

Despite the weight of all of this lineage, we have an extraordinary range of devices that somehow get lumped under the category "PC." Go back to the early '80s, and "PC" would evoke a desktop box from the business colossus IBM, but now the name doesn't belong to anyone, it still survives as "the PC."

Flip through any PC magazine and you'll see everything from bulky desktop computers to sleek business laptops; from expensive file servers to single-board devices only a few inches big. Somehow, all these machines are part of the same PC family, and somehow they can all talk to each other.

But where did all of this start? That's what we'll be examining: from the development of the PC to its launch in the early '80s, as it fought off giants such as Apple, as it was cloned by countless manufacturers, and as it eventually went 32-bit. We'll look at the '90s and the start of the multimedia age, the war between the chip makers, and the establishment of Windows as the world's leading operating system. Lastly, we'll examine the new millennium, initially dominated by Microsoft and the PC, followed by a slow shift to where we are now.

But before we go anywhere, to understand the revolutionary nature of the PC, you first need to grasp who IBM was at the time, and the culture that surrounded it.

THE LEAD UP TO THE PC

For decades, IBM was king, but the late 1970s brought a change in direction

IBM WAS FORMED in the early 20th century by people who invented the kind of punch-card machines and tabulators that revolutionized the previous century. IBM introduced big data to the US government, with its equipment keeping track of millions of employment records in the 1930s. It gave us magnetic swipe cards, the hard disk, the floppy disk, and even ATMs. It would develop the first demonstration of AI, and be integral to NASA space programs. IBM has employed five Nobel Prize winners, six Turing Award recipients, and is one of the world's largest employers.

When it came to respected marques, you couldn't get much higher than IBM, and the top brass knew it—to say the corporate culture was stuffy would be an understatement. Company pride and loyalty was instilled in all workers. IBM bosses insisted on well-groomed salesmen, with dark suits, white shirts, and "sincere" ties—there was even an IBM anthem and songbook. IBM's mainframe computers dominated the '60s and '70s, and that grip on the industry gave IBM an almost instant association with computers in the minds of American consumers. But trouble was on the horizon.

The late '70s were saturated by "microcomputers" from the likes of Apple, Commodore, Atari, and Tandy. IBM was losing customers as giant mainframes made way for microcomputers. As similarly large manufacturers were about to launch micros of their own, trying a new form of desktop computer was a way to fight back against rivals, but it would take a monumental shift in strategy.

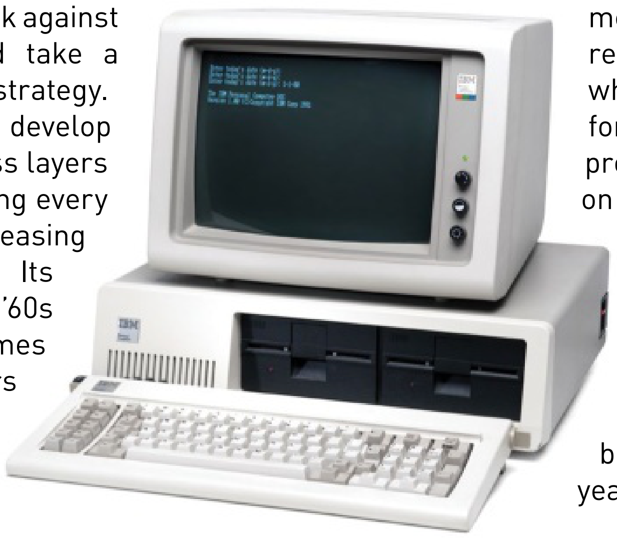
IBM took years to develop anything, with endless layers of bureaucracy, testing every detail before releasing anything to market. Its chief business in the '60s was huge mainframes that filled entire floors of a building, and took squads of people to run, while the so-called "minicomputers" of mid-'60s and '70s were still the size of a refrigerator.

IBM was a long way from offering simple and (relatively) affordable desktop computers, and didn't even have experience with retail stores. Meanwhile, microcomputer manufacturers were developing new models in months, and there was no way IBM could keep up while sticking to traditional methods.

ASSEMBLING THE CREW

In August 1979, the heads of IBM met to discuss the growing threat of microcomputers, and their need to develop a personal computer in retaliation. IBM president John Opel already recognized the potential in personal computers, but could also see the weakness in IBM's existing methods. In order to encourage innovation, IBM created a series of Independent Business Units, which were given a level of autonomy. One of these would soon be led by executive Bill Lowe, who would become the father of the PC.

In 1980, Lowe promised he could turn out a model within a year if he wasn't constrained by IBM's methods. Lowe's initial research led him to Atari, which was keen to work for IBM as an OEM builder, proposing a machine based on the Atari 800 line. Lowe suggested IBM should acquire Atari, but IBM rejected the idea in favor of developing a new IBM model instead. This model was to be developed within the year, with Lowe given an


At last, the PC, the IBM 5150, is ready to take on the world.

Desktop Predecessors

The IBM PC 5150 wasn't the first IBM computer to be called "PC."

Contrary to popular belief, the IBM PC was not the first personal computer, nor was it the first desktop computer by IBM. Microcomputers existed long before "the PC," and as for IBM itself, desktop computers had already been developed, though in very different forms to the PC we know now.

In 1973, IBM developed a prototype computer called SCAMP, which emulated an IBM 1130 minicomputer in a "portable" (we use the term loosely) boxed form factor, with a small monitor and keyboard built in.

Perhaps of most interest in relation to the 5150 Personal Computer is 1975's IBM PC 5100. Before you start jumping up and down, here the "PC" actually stands for "Portable Computer." This was similar to the SCAMP, but designed for mass manufacture, using an IBM PALM CPU. A good 64KB model cost just under $20,000, and that's in 1975 money.

Finally, there's IBM's System/23 Datamaster, released just before the PC. This was a definite desktop computer, with a relatively compact footprint, but it ran an 8-bit Intel 8085 CPU, and had two 8-inch floppy drives. Interestingly, the System/23 used the new Model F keyboard before the PC.

independent team. This new squad, the Dirty Dozen, a group of IBM misfits, was allowed to do things however they saw fit to get the job done. The task was code-named Project Chess, with Lowe promising a working prototype in 30 days.

After talking to potential dealers, Lowe went for an open architecture. While dealers were very interested in an IBM machine, it just wouldn't work if they had to operate within IBM's proprietary methods. If dealers were going to repair these machines, they needed to be made from standard off-the-shelf parts.

By August, Lowe had a very basic prototype and a business plan that broke away from established IBM practice. Based on this new open architecture, the PC would use standard components and software, instead of IBM parts, and be sold via normal retail channels.

DEVELOPING THE PC

Over the coming months, the Dirty Dozen grew exponentially in number and toiled away to transform the prototype into a world-class machine. They focused on giving the PC an excellent keyboard, which they delivered with the IBM Model F.

It needed to be durable and reliable, so each key was rated to 100 million keystrokes. It also needed to be tactile and ergonomic. IBM was renowned for quality keyboards, and would try to replicate the feel of older beamspring terminal keyboards with a new Buckling Spring technology.

These gave the keyboards the famous clacky sound and weighted feel that was popular with typists, giving a tactile feedback unrivaled at the time. The PC's keyboard alone would become the main selling point for a lot of customers, and IBM keyboards would be the best in the business for the next two decades.

Next, the crew turned to the CPU. IBM's own 801 RISC processor was considered (which would have been significantly more powerful), but for convenience and compatibility's sake, the team chose the Intel 8088.

By choosing an 8088 processor, technically the original IBM PC is only partly 16-bit. There is often confusion over why IBM chose to use the inferior 8088 CPU instead of the 8086 (especially with a so-called "x86" computer). Both are internally 16-bit, but the difference between the 8086 and the 8088 was the data path—the 8086 had a full 16-bit data path; the 8088's was 8-bit.

The 8088 was still quite fast, but was cheaper and could be bought in the large quantities the new PC market would demand. An 8086 would also require far more complex and expensive motherboards, and may not have been able to be produced in sufficient numbers to keep up with demand. A lot of the hardware likely to be used in the PC also had an 8-bit bus, so an 8088 would be better for compatibility.

As for the motherboard, RAM would be expandable up to 256KB, an optional 8087 math coprocessor would be available, and there would be five ISA expansion slots. Putting the machine together, launch models would have a choice of 16 or 64KB of RAM, space for two 5.25-inch floppy disk drives, and a cassette jack for tape storage. Buyers had a choice of monochrome or CGA graphics, and the Intel 8088 powering the system would be running at 4.77MHz.

With the hardware sorted, the burden of developing the operating system would be largely outsourced to Microsoft, with IBM offering consumers the joint-venture PC DOS. The final machine was dubbed the IBM Model Number 5150. This moniker would be immediately forgotten, for in the minds of the press, it was really IBM's Personal Computer that was about to launch.

IBM wasn't just a colossus in size, but also in sluggishness. Observers claimed it would take "nine months to ship an empty box."

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Apple II
The great rival

Without the Apple II, it's possible the PC would never have existed. Although a subject of debate, it's generally agreed that the Apple II was a primary influence on the PC. Many IBM engineers owned one—as did many customers, who found that they could easily do jobs, such as working on spreadsheets, that were nearly impossible on a giant mainframe.

Sporting an 8-bit MOS 6502 processor, with between 4KB and 64KB of RAM, it debuted in June 1977 for a base price of $1,298. It had an incredible production run, selling from 1977 to 1993. Developed by Steve Wozniak, the Apple II stands in stark contrast to products developed by Apple's lesser Steve (Mr. Jobs). Chiefly, the Apple II is designed around an open architecture, with a removable lid allowing easy access to the motherboard and expansion slots. Much like the PC, the Apple II would be the subject of numerous clones over the years.

Even though the PC was newer, the Apple II retained advantages over the PC, such as having eight expansion slots over the PC's five, and much more convenient gaming, with bundled joysticks and games that loaded in seconds.

An open architecture? Easy access to expansion slots? Steve Jobs could never have designed such a thing!

THE 1980s: THE PC OFFICIALLY LAUNCHES

Rivals were unfazed by the old timer's new machine, but had no idea what was about to hit them

AFTER A 12-month development, IBM announced its new Personal Computer on August 12, 1981. The $1,565 base model included 16KB of RAM, CGA graphics, and an input jack, relying on the user to provide a cassette deck (disk drives were optional and far more expensive).

Rivals such as RadioShack and Apple were unconcerned, as they had many times more dealers, large support networks, extensive software libraries, cheaper products, and models with better performance. Steve Jobs bought one to dissect and was unimpressed by some of its old-fashioned tech. In its hubris, Apple took out a full-page ad proclaiming "Welcome, IBM. Seriously." But it failed to recognize the weight a company like IBM carried with businesses.

Even though IBM's product was inferior in many ways to its cheaper competitors, businesses saw IBM as a safe bet, with excellent customer support. Within a year, the PC overtook the Apple II as the best-selling desktop computer. In 1983, two thirds of corporate customers standardized on the PC as their computer of choice, with only nine percent choosing Apple, and by 1984, the PC's annual revenue had doubled Apple's.

IBM surprised the industry by breaking its own traditions. Not only did it allow service training for non-IBM personnel, but it published the PC's tech specs and schematics to encourage third-party peripherals and software. Within a couple of years, the PC was the new standard for desktop computers, spawning a massive sub-industry of peripherals and expansions.

The Compaq Portable made waves as the first proper IBM-compatible. If you could lift it.

A 386 with VGA—ask someone to think of classic DOS gaming, and this is likely the first thing that comes to mind.

In 1982, the PC was updated to IBM's XT (eXtended Technology) standard, removing the cassette jack, and adding a 10MB hard disk. It was the first PC with a hard disk as standard.

August 1984 brought IBM's next major release, the PC/AT (Advanced Technology). Sporting a 6MHz Intel 80286 (aka 286—no one used the "80" prefix anymore), it came with 256KB of RAM, expandable up to 16MB. Initial models were limited to CGA and monochrome, but IBM's new 16-color EGA standard was soon introduced, allowing for 16 colors at 640x350. This was another step toward the PC we recognize now, with things like standardized drive bays, motherboard mounting points, and the basic keyboard layout we now take for granted.

THE IBM-COMPATIBLES

Although a hit with businesses, the first PC was too expensive for home users. The base model's price wasn't too outlandish, but it didn't include a monitor or floppy drive—a decent 64KB model

If it weren't for that nasty keyboard, perhaps the PCjr could have worked out....

PCjr

The PCjr looked promising: an Intel 8088 CPU, CGA Plus graphics, and the kind of sound chips used by Sega consoles. IBM promised a home machine with PC compatibility, improved graphics and sound, and a lower price of $1,269. Consumers adored the wireless keyboard, and it was IBM, the king of computing. Pundits thought the PCjr would destroy the competition, but on release it was universally panned.

A Commodore 64 was a third of the price, faster, with better graphics, and a huge software library. The PCjr's strange hardware and optimizations also meant it was only partially PC compatible, failing gamers and business users alike. What really riled consumers was the appalling rubber chiclet keyboard: A relatively expensive computer—from a company known for quality keyboards—was lumbered with something found on $99 budget micros.

Initial sales were a disaster, but a campaign of discounts, ads, and upgrades (particularly the keyboard) turned things around, making the PCjr a mild success. Nevertheless, its reputation was damaged—the PCjr was canceled in 1985.

with a floppy drive and monitor was more than $3,000 (over $8,000 in today's money). Rivals smelled opportunity, and with an open architecture, it wouldn't be long before IBM clones would arrive.

Initially IBM wasn't concerned: While a PC could be mostly replicated with retail parts, the BIOS belonged to IBM, which guaranteed proper IBM compatibility. However, companies such as Award and American Megatrends reverse engineered IBM's BIOS, and companies such as Dell, Compaq, and HP then used cloned BIOSes to build clone machines.

The first clone came from Columbia Data Products with 1982's MPC 1600, but 1983 saw the landmark Compaq Portable, the first computer to be almost fully IBM compatible. Compaq used its own BIOS and provided a very different form factor to a desktop PC, with all the components in one box, including a small CRT monitor.

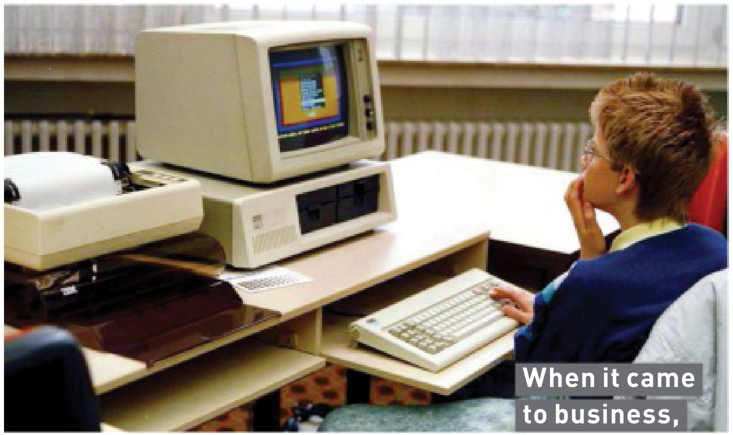
When IBM released its ill-fated budget PCjr in 1984, RadioShack made a clone, the Tandy 1000. It was far more successful than the PCjr, with better PC compatibility. After the PCjr's cancelation, existing software and peripherals came to be associated with the Tandy.

Far cheaper clones were eroding IBM's control of the market, with its share dropping from 76 percent in 1983 to 26 percent in 1986.

ENTER THE 386

At least IBM had the technological lead, but even that would be eroded when Compaq released 1986's Deskpro 386. Intel had recently released its 32-bit 80386 CPU, but unfortunately for IBM, Compaq beat it to market with a 386 machine boasting 1MB of RAM and MS-DOS 3.1. This was two to five times faster than a 286, with a base price of $6,500. Compaq's machines were the very top of the line, and would steal IBM's title of business leader.

IBM fought back with 1987's Personal System/2 (PS/2), finally releasing a 386 to market; the most powerful model sporting a 20MHz CPU, 2MB of RAM, and a 115MB hard disk. This was a landmark computer, standardizing on things such as a 1.44MB 3.5-inch floppy, and the PS/2 ports still used by mice and keyboards. However, the biggest leap was in the introduction of VGA graphics. On the desktop, this meant 640x480 in 16 colors, and a low-res mode of 320x200 in 256 colors, popular for gaming.



When it came to business, Apple forgot the adage, "No one ever got fired for buying IBM."

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Despite the incredible advances, IBM continued to lose ground to the clones. Although the PS/2 line sold well for a time, IBM's machines were still too expensive for the general public. As the '80s progressed, the name "PC" started losing its association with IBM, and the public started referring instead to "IBM-compatibles."

Although the PC was sweeping America, in many regions worldwide micros were still wildly popular—Europe was particularly enamored of the Atari ST and Commodore Amiga. Where PCs were lacking in the GUI stakes, these Motorola 68000-based machines already had sophisticated GUIs and astonishing multimedia capabilities that would trounce PCs for some years—often at a fraction of the cost.

Nevertheless, the PC continued to grow and develop, with further advancements such as 800x600 SVGA (Super VGA) graphics in 1988. And the '80s had one last trick up their sleeve: In April 1989, Intel released the 486, the powerhouse CPU that would kick-start the next decade. The first computer to ship was IBM's 486/25 Power Platform in October, making it the most powerful machine on the market.

However, 486 machines wouldn't enter most households until the 1990s—286s were still the order of the day, and many brands were still making budget XT clones. Where a 386 was considered the height of sophistication, a 486 was witchcraft. Nevertheless, the '80s were a time of astonishing technological progress: We entered the decade with 8-bit micros and left with full 32-bit processors and SVGA graphics. It's unlikely such rapid progress will be repeated.

The OS Wars Begin

The battle for which company and OS will rule the PC starts with the beginning of the PC itself. Mention "DOS" and Microsoft DOS will come to mind, but there are plenty of variants. Enter Digital Research's CP/M-86. CP/M was the original "DOS," shipped with most non-proprietary machines. IBM originally planned to use CP/M-86 with the PC, but negotiations went sour when IBM wanted to pay Digital Research a one-time fee, rather than on-going royalties.

Meanwhile, Microsoft had purchased a clone of CP/M-86 from Seattle Computer Products, 86-DOS (aka QDOS—Quick and Dirty Operating System). This was re-branded to MS-DOS and IBM's PC DOS, available for the PC. After Digital Research threatened legal action, IBM gave customers the option to buy either CP/M-86 or MS-DOS/PC DOS. MS-DOS/PC DOS was the substantially cheaper option, and outsold CP/M-86 in overwhelming numbers.

IBM and Microsoft's MS-DOS/PC DOS partnership wouldn't last long, with the two products gradually diverging over the years, with different features and compatibility. PC DOS was designed for genuine IBM hardware, and as IBM compatibles took over the market, the more generic MS-DOS would become ubiquitous. Regardless, both versions would stay in production until the turn of the century.

IBM
IBM
1.1
Personal Computer
Computer Language
Series
Disk
Operating
System
by Microsoft
IBM

IBM's PC DOS "By Microsoft" partnership didn't last long.

THE 32-BIT ’90s

A decade when computers would adopt desktops and multimedia

PREVIOUS VERSIONS of Windows were unsuccessful, but with 1990’s Windows 3.0, the PC desktop was seen as a viable alternative to the Macintosh and Amiga. Windows 3.0 had a new interface, multitasking abilities, and mouse-driven productivity suites that freed users from the command line.

Meanwhile, IBM’s OS/2 had been trying to establish itself as the respectable GUI for corporate America. By 1990, the alliance between IBM and Microsoft had essentially finished, with the two becoming rivals. Although newer versions of OS/2 would be more advanced, for now Microsoft had the technological advantage. IBM was still hampered by 286 machines, keeping OS/2 primarily 16-bit, unable to use the advanced features of the 386.

April 1992 finally saw OS/2 become 32-bit. In most ways, it was superior, with extensions to DOS, and Windows 3.x support in a stable environment. But while Windows targeted clone machines, OS/2 targeted IBM hardware, so it couldn’t run on many clones where Windows ran perfectly. Furthermore, while IBM sold OS/2 as a separate product, Microsoft bundled Windows with new PCs.

Microsoft’s dominance started with Windows for Workgroups 3.11 in August 1993. It had new 32-bit capabilities and proper networking. It devoured the business space, and 3.11 would be the environment many people grew up with.

THE MULTIMEDIA AGE

In the mid-’90s, every PC had a soundcard, CD-ROM drive, and tinny set of multimedia speakers. CD-ROM’s 650MB of storage allowed more expansive gaming, with FMV cutscenes and CD-audio soundtracks. Schools bought edutainment packages with archived video and interactivity.

By now, the 486 was standard. Although 386s were still functional business machines, you needed a 486 to enjoy this era. Thankfully, hardware prices fell dramatically; while ’80s PCs usually had Intel CPUs, rival manufacturers were on the ascent and lowering costs.

Although AMD CPUs were often from a previous generation to Intel’s, its chips were more efficient and allowed higher clock speeds, giving similar performance at much lower prices. Cyrix was making a name for itself with 486-upgrade processors, providing a cheap upgrade route for 386 owners with a new CPU in their old motherboard.

1993’s Intel Pentium brought the next generation of CPUs. Intel dropped the “86” to differentiate itself from other manufacturers, with “Pent” coming from the Greek “penta,” meaning five (implying a 586 without saying it).

The Pentium gave almost twice the performance per clock cycle as the 486, but early Pentiums were only 50–66MHz. Meanwhile, AMD was pumping out insanely overclocked 486s, such as the DX4-120 running at 120MHz, nearly matching early Pentiums. AMD’s strong performance and low prices attracted manufacturers such as Acer and Compaq, whereas Cyrix’s efficient designs caught IBM’s eye, starting a partnership in 1994.

1995 saw the introduction of the ATX standard we use today, defining new mounting placements and features like automatic shutdowns. Unlike XT and AT, this change was brought by Intel instead of IBM.

August 1995 would see the biggest change to the computing landscape yet: Windows 95. On the technical side, Windows 95 was designed around 32-bit pre-emptive multitasking, compatibility with existing DOS and Windows programs, and new tech such as DirectX and Plug and Play support. But the real change was the interface. A taskbar, a “Start” button in the bottom-left, the “Maximize,” “Minimize,” and “Close” buttons at the top-right of the window.... We take these norms for granted now, but they started with Windows 95.

Windows 95 truly established the Microsoft goliath. Computing had become mainstream, and Microsoft was a household name. It was over for competitors: Commodore had gone bankrupt, Atari hit the wall, and Apple was barely surviving. IBM still had OS/2, with its newer Warp release from a year prior, but this

A typical ’90s gaming PC, where a 3D accelerator would make you the envy of all n00bs.

The 386 and the 32-Bit Era

It’s difficult to overstate the 386’s importance. In short, the 32-bit 386 is where modern computing began. List the features of a modern OS, and for the PC, these abilities started with the 386, serving as the basis and minimum spec for the next generation of OSes in the ’90s.

With the 386, PC operating systems immediately became more advanced, with a flood of Unix variants being ported to the platform. Advanced computing was previously dominated by expensive Unix workstations, but once the PC went 32-bit, they grew redundant, and big Unix companies such as DEC and Sun Microsystems started falling away. Until late 2012, a 386 could still run Linux (now it requires a decadent 486).

intel
i386
A80386DX-16
SX213
L9311389
INTEL ’85

Put a squeaky millennial in front of a 16-bit machine and they won’t know what they’re looking at, but with a 386, they might stand a chance.

only supported Win 3.x applications and sank into irrelevancy.

When Windows 98 arrived, it fixed many of the teething problems of Win 95, with a more stable system, better hardware support, and UI enhancements. This was also when the anti-trust lawsuits began, as Microsoft bundled Internet Explorer with Windows, itself already bundled with new computers. Now Microsoft would dominate not just PCs, but Internet browsers too.

IBM may have been struggling to sell desktop computers, but it made a killing with its new ultra-rugged ThinkPad laptops.

THE PERFORMANCE AGE

3D accelerator cards—such as 3dfx's Voodoo 2, Nvidia's Riva TNT, and ATI's Rage series—would be a defining feature of the late '90s. 3D acceleration brought a new era of PC gaming. Where previous games relied on the CPU for all rendering, these new graphics cards added a GPU (graphics processing unit), which took the graphical processing burden away from the CPU, allowing substantially faster gaming and stunning graphical effects.

Although 3dfx tried to corner the market with its proprietary Glide API, it eventually lost out to competitors who used market standards such as DirectX and Silicon Graphics's OpenGL. The ultimate card of the '90s would be 1999's Nvidia GeForce 256.

This point is where the CPU race is whittled down to AMD and Intel.

Until now, things looked great for Cyrix. The mid-'90s saw 5x86 upgrade chips for 486 machines, followed by the 6x86 in October 1995. The 6x86 out-performed mid-level Pentium machines for less money—Cyrix was becoming a technological leader rather than just a budget manufacturer.

Business was good until complex 3D games such as *Quake* uncovered Cyrix's embarrassing floating point and integer performance. Cyrix was great at spreadsheets, but terrible at gaming, which tarnished the brand. 1997's MediaGX helped improve things, with a system-on-chip design perfect for laptops and the budget PC market, but as Intel continued to advance, Cyrix did not.

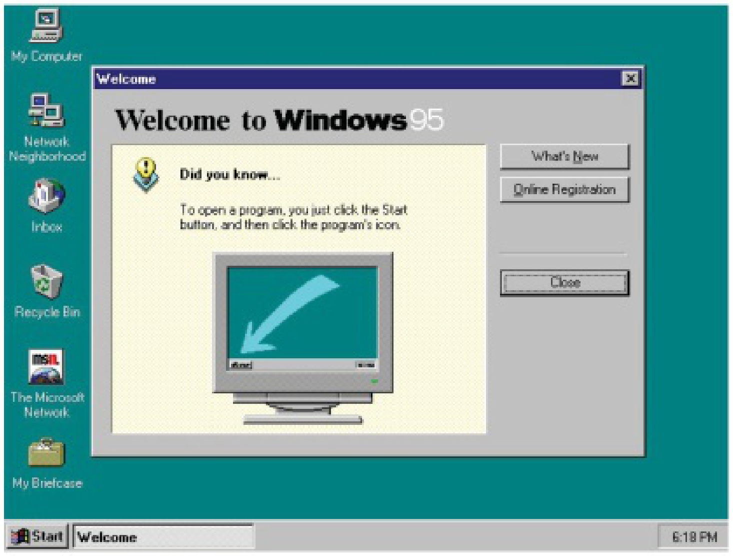
Newer-generation CPUs were really highly overclocked 6x86s—prone to high failure rates, still poor at gaming. The Cyrix-IBM partnership ended in 1998, and worse yet, Intel soon entered the budget market with its Celeron line. Cyrix was out of cash, and its tech was bought out by VIA in 1999, who gradually phased out the brand.

AMD, meanwhile, went from strength to strength. During the Pentium era, reverse-engineering Intel's processors became too complex, so AMD started designing its own style of processors, rather than follow Intel designs.

In 1996, AMD released the K5, the first Pentium rival, but 1997 brought true success with the K6. This was a proper rival to the new Pentium II, but could work in older Socket 7 motherboards. The K6 series was wildly successful, with its famous 3DNow! instructions, and cheaper prices. The successive K6-2 and K6-3 chips continued to rival advancing Pentium II and III models, and would eventually dominate most of the sub-$1,000 market.

We would end the decade with 1999's K7 Athlon, the first retail CPU to break the 1GHz mark.

The '90s were a time of survival of the fittest, ending with one dominant OS and two CPU makers. Thankfully, the GPU market still had a few years of diversity remaining.



Did you know...

To open a program, you just click the Start button, and then click the program's icon.

Other than the dull colors, Windows 95 is where the PC started to resemble the interface of today.

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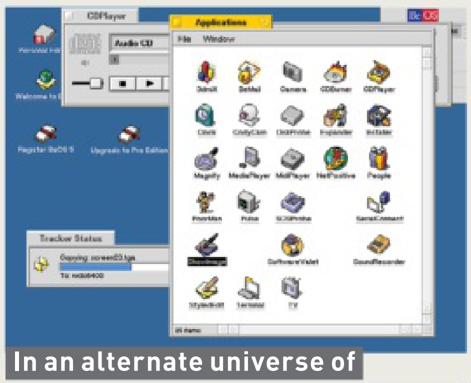
BeOS
The sleek alternative

Be Inc. (founded by ex-Apple executive Frenchman Jean-Louis Gassée) launched the BeBox in October 1995, running its own operating system, BeOS. Optimized around multimedia performance for the masses, BeOS was intended to compete with both Mac OS and Windows. Lightning fast and free of the legacies of old 16-bit hardware, BeOS had features such as symmetric multiprocessing for multi-CPU machines, pre-emptive multitasking, and the 64-bit journaled file system BFS.

Although the BeBox itself was unsuccessful, BeOS was ported to the Macintosh in 1996, and almost became the new system to replace Mac OS. Gassée's $300 million asking price was too steep, however, and Apple went with Steve Jobs's NeXTSTEP OS instead. BeOS was then ported to the PC in 1998, along with a free stripped-down BeOS 5.0 Personal Edition, but it failed to gain more than a niche audience (Microsoft may also have worked against its adoption). Be Inc. was bought out by Palm Inc. in 2001.

Despite numerous recreations, BeOS is now survived by Haiku, a popular open-source re-implementation with BeOS binary compatibility on 32-bit versions.



In an alternate universe of Betamax VCRs, where Al Gore was president, BeOS reigns across Macs and PCs.

BEYOND 2000

Microsoft totally dominates the start of the millennium, but this decade ends elsewhere

After 2007's iPhone, Apple shifted industry focus to portable devices, becoming the world's biggest company in 2012.

THE NEW CENTURY would start with Windows 2000 (arguably the best release of Windows) and Windows Me (arguably the worst). Win 2000 was based on Microsoft's NT platform, finally moving Windows away from DOS, while remaining mostly backward compatible with Windows 9x and DOS programs. 2000 had the stability of NT and the minimal aesthetic of the 9x series, without the bloat of future releases.

Later in the year, Microsoft released Windows Me (Millennium Edition)—still based on Windows 9x, which was still based on DOS. Often regarded as Microsoft's worst operating system, it somehow managed to be buggier and less refined than previous 9x releases. Whereas Windows 2000 is remembered as an underrated gem, Windows Me brings cold shivers down the spines of IT staff who lived through that scary time.

October 2001 saw the release of Windows XP, using the same NT base as 2000, with a revamped interface, and improved multimedia capabilities. While previous versions of Windows were pretty drab, XP was colorful. XP made piracy much harder, being the first Windows to have an activation scheme. The mix of relative stability and a friendly GUI made XP one of the most popular OSes of all time. Microsoft kept having to extend support for XP, right up until 2014, when it officially cut the cord. Despite this, there are still plenty of XP users, spreading digital disease across the Internet.

PLATFORM SHAKE-UPS

In April 2003, AMD released its 64-bit Opteron processor. This was the first major change to the x86 platform not made by Intel, and would be labeled either x86-64 or, embarrassingly for Intel, AMD64. Intel was forced into the position of modifying its processors for software compatibility with AMD's new specification. Although it would take a few years for the new spec to catch on, it would eventually become the standard in use today.

In May 2005, IBM sold its PC division to Lenovo in a deal worth nearly $2 billion. As part of the deal, IBM would acquire a stake in Lenovo, and sell Lenovo goods under a marketing alliance—existing lines like the famous IBM ThinkPad laptops would be sold as Lenovo ThinkPads. Skepticism was high over the viability of such a merger but Lenovo went on to become the biggest PC vendor in the world, while IBM would focus on big-data markets and the cloud.

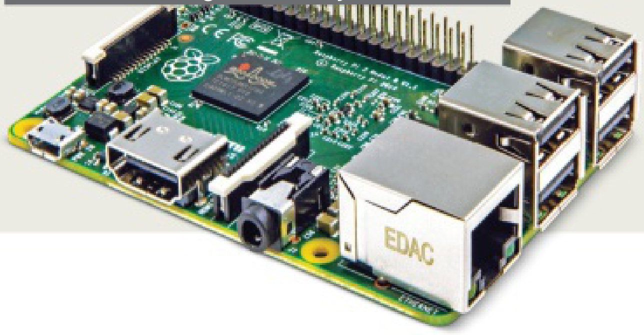
In June 2005, Apple announced that Macs would switch from PowerPC to x86 processors. Steve Jobs was disappointed in the progress of PowerPC CPUs, which were slower than Apple had promised consumers, too hot for laptops, and consumed too much power. Although the market was concerned, the Intel machines were faster than their PowerPC counterparts, and sales increased.

Between July and October 2006, AMD bought out graphics company ATI Technologies in a deal worth $5.6 billion. Merging ATI's graphics tech with its existing CPU know-how, AMD was now taking on the might of both Intel and Nvidia with

The Raspberry Pi Revolution

In February 2012, the successful Raspberry Pi was released, taking the industry by storm with a new form factor, often referred to as a single board computer (SBC). Made in Britain from a combination of cell phone and desktop parts, the Pi is barely larger than a credit card, for $35. The Pi was intended to get kids programming after the Raspberry Pi Foundation recognized a national decrease in programming skills, but it became more popular with hobby builders and the embedded computing industry.

Unfortunately for PC giants, the Pi ran Linux on an ARM CPU instead of Windows on x86. Due to its popularity, Microsoft ported Windows to the system a few years later, and manufacturers started producing rival machines. For the ARM crowd, there are products like the Asus Tinker Boards or Pine 64's RockPro64. For the x86 crowd, there are products like the Atomic Pi and the LattePanda series. ARM boards are generally cheaper and more efficient, while x86 boards can often run regular builds of Windows or Linux.


In spite of imitations, the Raspberry Pi still sets the standard and has spawned an entire cottage industry of add-ons.

To confused audiences worldwide, CEO Satya Nadella announces Linux-based Microsoft technologies.

the manufacturing strength of combined technologies.

THE VISTA HITS THE FAN

In January 2007, Windows Vista was released. Even though it was based on NT, Vista had a vastly different framework from previous versions, making for an essentially new platform. Vista was designed to be more secure, showcasing new features like intelligent RAM storage, and an updated GUI with effects like window translucency, but it was savaged by the press.

Windows Vista had bad backward compatibility, long loading times, and a stream of invasive warning messages. It improved with time, but the damage was done—computer manufacturers started shipping PCs with the option of XP. Microsoft would learn from its mistakes with the next release.

Windows 7 arrived in July 2009. Based on the same platform as Vista, it refined the codebase, bringing performance improvements, better stability, and a sensible interface.

To pick some highlights from a long list of new features, Win 7 had faster boot times, better multicore performance, easier networking, new virtualization tech, and better backward compatibility. The UI changes were popular, including a new taskbar with more functionality, and the Snap function, which moved and resized windows when dragged against the screen edges.

Windows 7 would become the fastest selling OS in history, and around a third of PCs still use it. It's well regarded among IT staff, and many users are avoiding the switch to Windows 10, despite Extended Support ending next year.

In July 2012, Google's Chrome browser overtook Internet Explorer in usage share, and by April 2013, both Chrome and Firefox had a greater share of users than Internet Explorer, ending Microsoft's dominance of the browser market.

In October 2012, Windows 8 was released. Despite Microsoft's attempts to innovate, Windows 8 was critically savaged. As mobile devices were overtaking traditional desktops, Win 8 tried to have more of a "touch" interface, removing the "Start" button, and switching to a tile-based design. The result was a dreadful unintuitive compromise. Win 8 also introduced the Windows Store, a Microsoft-governed system for buying apps, in the style of Apple. This restrictive way of buying software drew criticism, especially from Valve, who started its own SteamOS in response.

Windows 8.1 addressed many of its criticisms, chiefly by bringing back the "Start" button and allowing users to boot a traditional desktop. But again, the damage was done. While Windows 7 is still in heavy use, Windows 8 is almost forgotten.

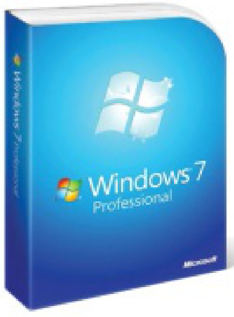
WHERE ARE WE NOW?

We end the decade with Windows 10 (released July 2015). Reception has been mixed. On the plus side, the interface is a more functional blend of Windows 7's traditional GUI and Windows 8's tile system, and Windows finally has virtual desktops (something featured in other OSes for decades). On the down side, forced system updates continue to infuriate users, there is a worrying amount of data collection, and the Microsoft Store undermines the open nature of the PC platform.

Microsoft still dominates the PC desktop, but is no longer a monopoly, with Apple having spent most of the decade wealthier than Microsoft. Niche OSes are growing in popularity. Linux is creeping into everything from DVD players to the world's supercomputers. Microsoft has gone from calling Linux "a cancer" to proclaiming "Microsoft loves Linux," shipping Windows with a Linux kernel, and running its own Azure Sphere Linux distribution for IoT devices.

To focus on the PC, it isn't the dominant format it once was. IBM has long since left the market it created, and wisely so. Computing is more varied and takes many forms, from iPads to smartphones, from Chromebooks to weird Android devices no one can categorize. Computing has returned to a diversity like the '80s, but the PC no longer has the same supremacy—nor do the giants that established it, such as IBM, Intel, and Microsoft.

After Vista was poorly received, Microsoft won back consumer confidence with 2009's Windows 7.



STORE
LIBRARY
COMMUNITY
DAYS TO DIE
WARFRAME
PAYDAY 2
Now Available for Early Access!
$29.74
TOP SELLERS
SPECIALS
WEEKEND DEAL
DAILY DEAL
COMING SOON
WEB
SELECT
SEARCH
FRIENDS

What About SteamOS?

When Microsoft released its proprietary Windows Store, Valve's Gabe Newell described it as a "catastrophe for everyone in the PC space." Valve felt that the Windows Store threatened Steam's existence, and decided to branch out with its own platform, using Linux as a base. First, Valve released the full Steam gaming client for Linux in February 2013, followed by its own platform, SteamOS, based on Debian Linux in December 2013. (Linux and SteamOS applications are generally cross-compatible.) However, SteamOS failed to gain much traction, and most of the user base would come from the regular Linux client.

Perhaps following the advice of id Software's John Carmack, Valve re-focused its attention from encouraging native SteamOS/Linux ports to perfecting Wine, the Windows compatibility layer for Linux. In August 2018, Valve released Proton, a modified version of Wine with a DXVK translation layer to convert between newer Direct3D system calls and Vulkan. It should be noted that Proton can be used for regular apps, not just gaming, so the more obscure games that can run, the more likely it will run any Windows apps without problems. Over half of all Windows games run out of the box, and that rate is growing steadily.

© APPLE, STEAM, MICROSOFT

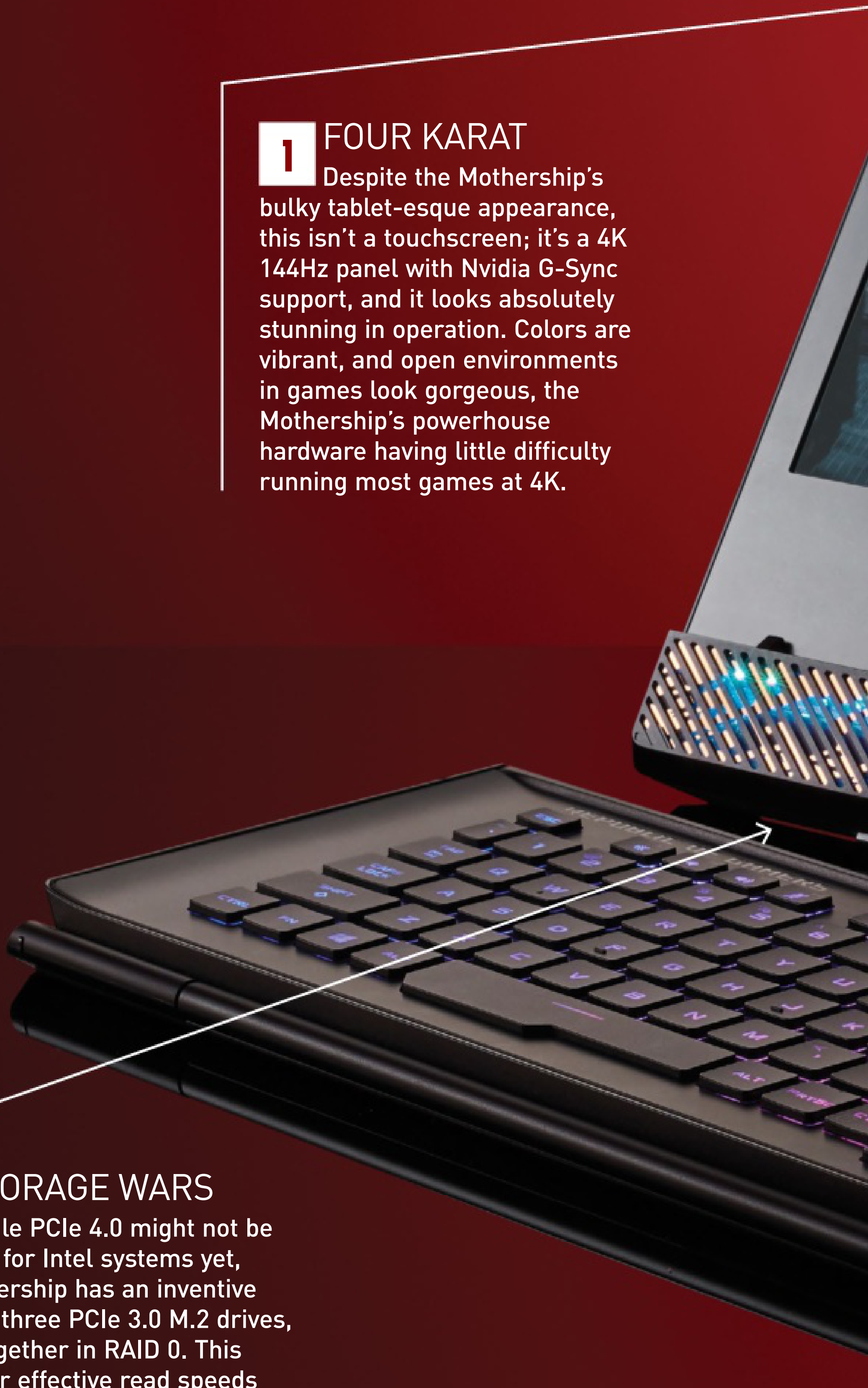
TECH PORN

Asus ROG Mothership

WE'VE NEVER SEEN anything like this. The ROG Mothership stands tall, resembling the result of an unholy union between the Microsoft Surface tablet and a hefty gaming laptop. Functionally, it sits firmly in the latter camp; with a ninth-gen Intel Core i9 processor, an Nvidia GeForce RTX 2080 GPU, and 64GB of DDR4-2666 memory, the Mothership is ready to handle just about any triple-A game.

The keyboard can either be aligned like an ordinary laptop or detached and folded in two for more casual control. The screen (and the computer itself) is held upright by a metal fin that extends from the rear, enabling you to adjust the angle at which the screen sits, and improving airflow to keep the GPU cool. It's a heavy unit, with two big power adapters for maximum overclocking potential.

A desktop replacement for the 4K age, it's equipped to handle gaming, video editing, and much more. Its sides bristle with ports: two USB-C, four USB, an SD card reader, and an HDMI out. It's got audio handled, too: The upright form factor allows for four speakers along the front, blasting high-quality sound directly at you for an immersive experience. **–CHRISTIAN GUYTON**



1 FOUR KARAT

Despite the Mothership's bulky tablet-esque appearance, this isn't a touchscreen; it's a 4K 144Hz panel with Nvidia G-Sync support, and it looks absolutely stunning in operation. Colors are vibrant, and open environments in games look gorgeous, the Mothership's powerhouse hardware having little difficulty running most games at 4K.

2 NUMBER ONE

The number pad is concealed beneath the vertical trackpad on the keyboard. With the click of a button, the red number pad matrix illuminates, and overrides the trackpad functions. That's OK—as with any high-power laptop, most users will plug in a mouse for regular use, leaving the trackpad as the perfect place for number input.

3 STORAGE WARS

While PCIe 4.0 might not be available for Intel systems yet, the Mothership has an inventive solution: three PCIe 3.0 M.2 drives, linked together in RAID 0. This makes for effective read speeds of over 8GB/s, more than the theoretical maximum of PCIe 4.0.

RECESSED CROSSWALK ON 6 AVE
RAISE PLOW

© GETTY IMAGES

HOST YOUR OWN PASSWORD SERVER

Take control of how your passwords are synched and where they're stored

BY NICK PEERS

EVERYONE NEEDS a password manager. You simply can't get by online these days relying on a handful of easily guessable passwords—just take a trip to https://haveibeenpwned.com to confirm your trusted passwords of yesteryear have almost certainly been exposed by now.

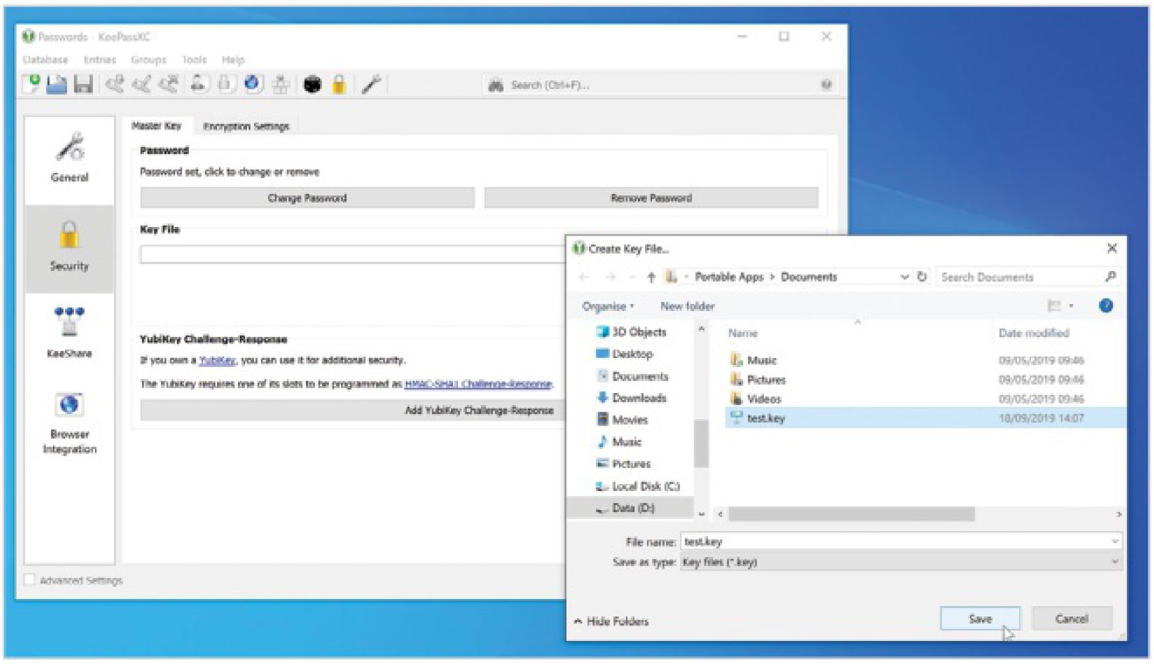
The value of a password manager can't be overstated, whether it's generating unique, random, lengthy passwords that are almost uncrackable, or storing them securely in a vault protected by strong encryption and—if you're diligent—extra layers of security. But it's not necessarily all good news. Where is your password vault stored, and who can access it?

Services like LastPass and 1Password that make it easy to sync and access passwords between mobile, desktop, and browser store your encrypted vault on their own online servers. They argue their "zero knowledge" model, where they have no access to your password or the keys that encrypt your file (which is done locally on each device), keeps them nice and secure. Great, but that's an awful lot of trust you're placing in their hands—they're not immune to attack, and while LastPass maintains no encrypted vault data was compromised when its security was breached in 2015, hackers were still able to access the files, putting any vaults protected by weak passwords at risk.

So, how do you ensure your passwords can't fall into the wrong hands? You could go old school and use a single password manager app on your PC, where the vault is encrypted and stored locally (perhaps backed up to a USB key, stored in a fireproof safe). That's almost watertight, but at what cost? Convenience, for one: Copying passwords by hand on your phone or using the clipboard to transfer passwords from app to browser is slow.

The solution lies somewhere between foolproof security and the convenience of being able to sync and access passwords on the go. Over the page, we reveal how to find the perfect balance, with the help of one of three password managers.

WHAT SHOULD YOU look for in your finely balanced password manager? First, it must be cross-platform—apps for Windows, macOS, and Linux, plus browser add-ons, and mobile support on iOS and Android. Second, you need full control over where your passwords are stored—whether your own hosted server or choice of cloud storage provider. Third, we want better transparency from our password managers, which is where open source comes in. And fourth—not mandatory, but preferably—support for additional forms of authentication to protect your password vault, such as 2FA or key files.


Passwords - KeePassXC
Database
Entries
Groups
Tools
Help
Search (Ctrl+F)...
General
Security
KeeShare
Browser Integration
Master Key
Encryption Settings
Password
Change Password
Remove Password
Key File
YubiKey Challenge-Response
Add YubiKey Challenge-Response
Advanced Settings
Create Key File...
Portable Apps
Documents
Search Documents
Organise
New folder
3D Objects
Desktop
Documents
Downloads
Movies
Music
Pictures
Local Disk (C:)
Data (D:)
Name
Date modified
Hide Folders
Save
Cancel

Password set, click to change or remove

If you own a YubiKey, you can use it for additional security.

The YubiKey requires one of its slots to be programmed as HMAC-SHA1 Challenge-Response.

Music 09/05/2019 09:46
Pictures 09/05/2019 09:46
Videos 09/05/2019 09:46
test.key 10/09/2019 14:07

File name: test.key
Save as type: Key files (*.key)

Add an extra layer of security to your KeePassXC vault.

THREE OPTIONS HIT THE SPOT

We've settled on three potential solutions. The first is KeePass, the open-source desktop password manager. If you already store all your passwords in a KeePass database, it makes sense to continue using this feature. Check out the box opposite for the quickest way to get a multi-platform, cloud or network-synched password setup using KeePassXC.

If you plan to store your database online for always-accessible synching, we strongly recommend making use of KeePassXC's additional security options to protect your file if the server it's stored on is compromised. You can pair it with a physical YubiKey, or create a special key file that's required alongside your password to open the file, so even if your password is subsequently discovered, the vault remains off limits.

To add a key file, choose "Database → Change master key," click "Add additional protection," then "Add Key File." Click "Generate" to create the file—we suggest saving this in a different location from your password file. One option would be to store it on another cloud platform (for example, Google Drive if your main file is synched via OneDrive).

BUILD ME UP, BUTTERCUP

Our second solution is Buttercup (https://buttercup.pw). It checks all the platform boxes, with support for Firefox and Chrome browsers. Unlike KeePass, which relies on third-party mobile support, all Buttercup apps are native (and completely free). Like KeePass, there's no proprietary server on which your password vault is stored, but support for synching via the cloud is baked into Buttercup's DNA.

This is evident from the moment you download and install the Windows client. On first launch, you're invited to click "Add archive" to set up a new vault. From here, you can create a new archive—which you store locally—or choose "Connect Cloud Sources" from the pop-up menu to create an online archive for synching purposes.

The Windows desktop client supports just four services: Dropbox, OwnCloud, NextCloud, and WebDAV (which includes Box among its supported clients). Google Drive is conspicuous by its absence, despite the fact it's an option in both the browser add-on and mobile apps—as a workaround, if you have Backup and Sync installed on your computer, generate a new local archive, and save it in your Google Drive folder to make it accessible to your browsers and mobile devices.

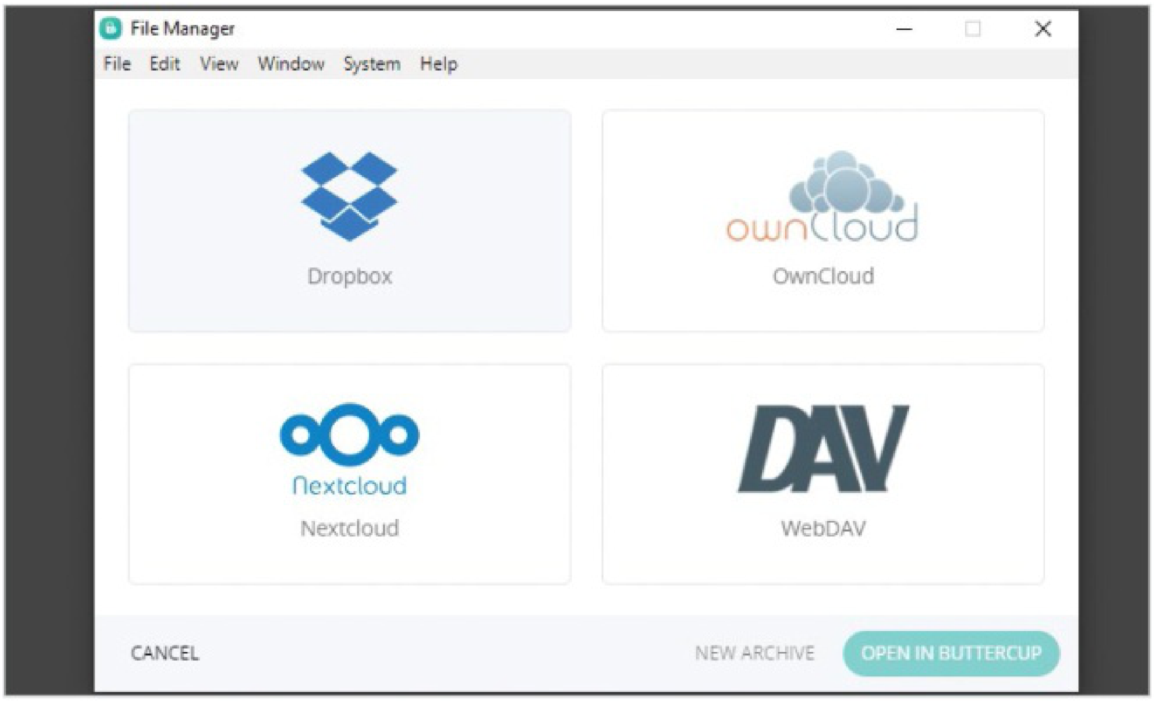
Next, enter a master password to protect your newly created archive—the usual caveats apply: Make it as long as possible, and try to avoid making it obvious. That said, it's the one password you need to remember going forward, so don't make things too difficult for yourself. Click "Confirm" and retype the password before clicking "Confirm" again.

One of Buttercup's neat features is that it makes it easy to manage multiple vaults at the same time—you can create more than one and switch between them easily. Use this to segregate passwords from each other—you could, for example, keep all your online passwords in one vault synched to your cell phone and browser, while offline passwords remain stored on your PC only.

CREATING & MANAGING PASSWORDS

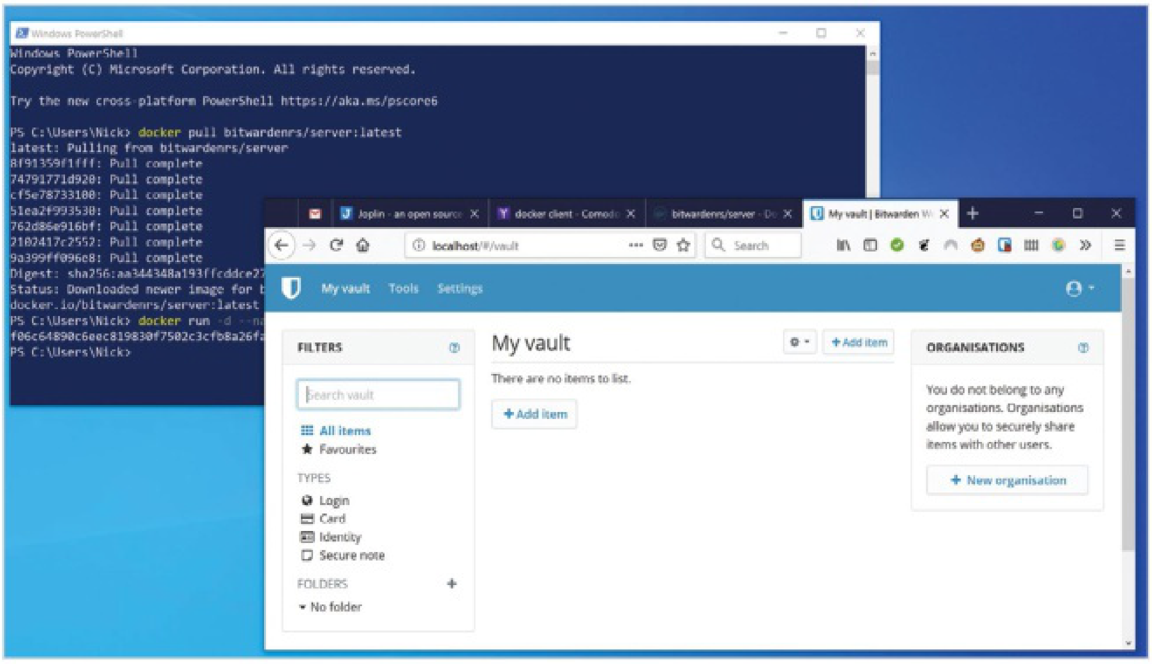
By default, the desktop application is designed primarily to organize your passwords into folders (or groups), plus create new passwords from scratch. Here, only title, username, and password fields are provided—if you plan to manually create web logons, you need to click "Add new field," enter "URL" for the "Label," then type the web address into the "New Field" box to convert it into something that works with the Buttercup mobile app or browser add-on.

Look out for the magic wand button next to the password feature—clicking


File Manager
File
Edit
View
Window
System
Help
Dropbox
ownCloud
OwnCloud
Nextcloud
Nextcloud
DAV
WebDAV
CANCEL
NEW ARCHIVE
OPEN IN BUTTERCUP

Direct sync support is currently limited to four options in Buttercup.

© KEYPASSXC, BUTTERCUP, MICROSOFT, 8BIT SOLUTIONS LLC



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Nick> docker pull bitwardenrs/server:latest
latest: Pulling from bitwardenrs/server
8f91359f1fff: Pull complete
74791771d920: Pull complete
cf5e78733100: Pull complete
51ea2f993530: Pull complete
762d86e916bf: Pull complete
2102417c2552: Pull complete
9a399ff096c8: Pull complete
Digest: sha256:aa344348a193ffcddce27
Status: Downloaded newer image for b
docker.io/bitwardenrs/server:latest
PS C:\Users\Nick> docker run -d --na
f06c64890c6eec819830f7502c3cfb8a26fa
PS C:\Users\Nick>
```

There are no items to list.

You do not belong to any organisations. Organisations allow you to securely share items with other users.

You can install a Bitwarden server in Windows 10.

this enables you to generate a random password of 10–50 characters. This can be random characters or words—choosing characters enables you to select what types to include, from alphanumeric to spaces, dashes and underscores, and symbols. Click "Generate" to keep generating passwords until you find one you like, then click "Use this" to record it.

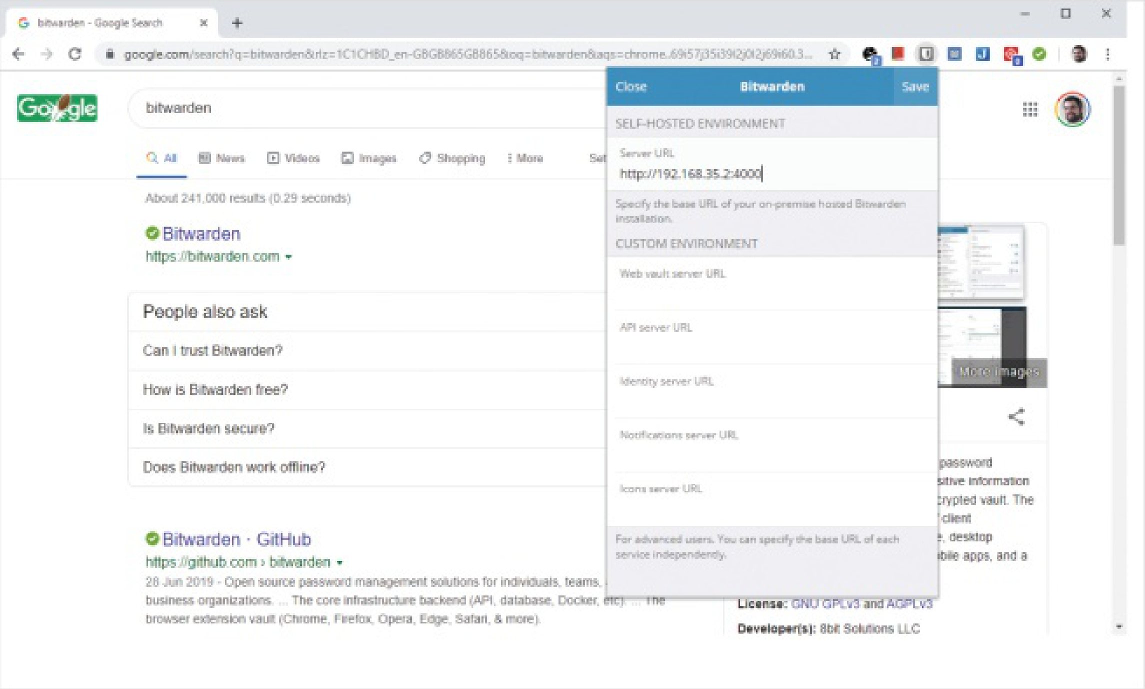
If you're migrating from another password manager, you may be able to import your passwords into Buttercup to save time having to recreate them from scratch. Choose "File → Import," where you'll find options covering 1Password (.1pif), KeePass (.kdbx), LastPass (.csv), Bitwarden (.json), and previous Buttercup installations (.csv). 1Password and KeePass users are prompted for the master password from the original vaults.

EXTEND TO MOBILE AND BROWSER

Most of your logins will, of course, be linked to websites—while we've shown it's possible to set these up in the desktop application, a far better option is to install the browser add-on and/or mobile apps. These work in a similar way. First, click "+" to add a new archive or link to an existing one. If you select "System → Enable Browser Access," you can link your browser add-on to a password file stored on your PC; otherwise, it's a case of selecting your chosen cloud provider (including Google Drive, of course) to log in, browse, and select the archive file.

After entering your master password, you're prompted to give this archive a name—this is purely for identification purposes, so doesn't need to match its file name. Now your archive is connected to all your devices, you can update it from browser, mobile, and desktop, but sometimes changes are slow to appear—to force a sync in the desktop application, for example, choose "View → Reload."

When you next log into a website using your browser, Buttercup pops up a prompt



Server URL: http://192.168.35.2:4000

Specify the base URL of your on-premise hosted Bitwarden installation.

For advanced users. You can specify the base URL of each service independently.

Click the "Settings" button to configure access to your Bitwarden server.

SYNC IN KEEPASS

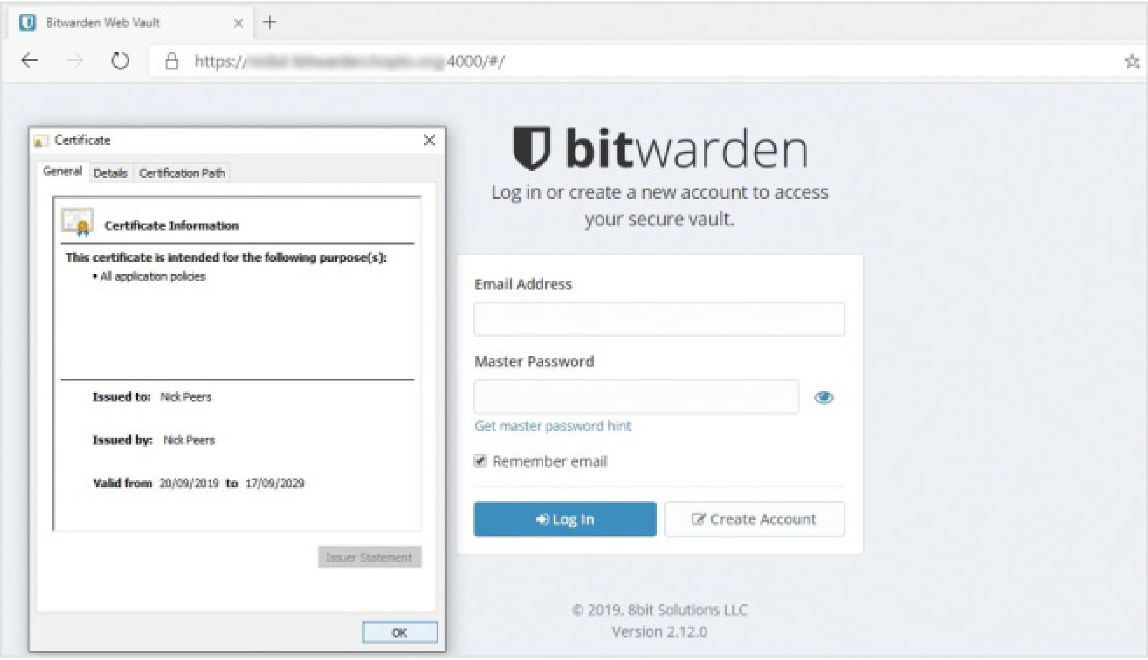
There are ways to keep your database in sync between multiple desktops and mobile devices using the main KeePass (https://keepass.info) application, but if you're looking for a straightforward, cross-platform approach, consider choosing the more user-friendly KeePassXC fork (https://keepassxc.org), which has been designed to make things easier for multi-platform use (Windows, Mac, and Linux; Chrome and Firefox browsers; plus mobile).

KeePassXC works with existing KeePass databases, so once installed, start by loading it in. Next, enable Firefox and Chrome-based browsers to access the passwords in the database by navigating to "Tools → Settings → Browser Integration" and checking the appropriate box. See https://keepassxc.org/docs/keepassxc-browser-migration/ for additional instructions if required.

Keeping the database in sync with other desktop clients can be achieved by simply storing your database file inside a folder accessible to all, whether that's a folder on your NAS for synching exclusively over your local network or the folder used by any cloud provider, such as Dropbox or OneDrive, installed on your PC.

When it comes to extending KeePassXC to your cell phone, there's no native application provided, but the KeePassXC team recommends one of KeePass2Android for Android users and Strongbox Password Safe for iOS. Both enable you to sync your mobile vault with the desktop file using supported providers (you need the requisite cloud app installed on your phone).

Both Android and iPhone apps work in a similar fashion: Open the app and choose to add an existing database when prompted. Select your cloud provider from the list, then browse to your synched database file and select it. Provide your password (and select your key file if necessary) to gain access to your saved passwords from your phone. iPhone users should navigate to "Settings → Passwords & Accounts → AutoFill Passwords" to configure Strongbox to automatically fill login boxes, too.


Bitwarden Web Vault

https://[redacted]4000/#/

Certificate

General | Details | Certification Path

Certificate Information

This certificate is intended for the following purpose(s):
- All application policies

Issued to: Nick Peers

Issued by: Nick Peers

Valid from 20/09/2019 **to** 17/09/2029

Log in or create a new account to access your secure vault.

Email Address

Master Password

☑ Remember email

© 2019, 8bit Solutions LLC
Version 2.12.0

It's tricky, but you can secure your Bitwarden self-hosted server.

to save the username and password into its archive: Click "Save" and a new tab opens with the new entry details showing name, username, password, and URL. Review and edit these if necessary, then select your archive followed by a group (this is mandatory, so consider creating one in the desktop application—"Web passwords, for example"—if necessary), before clicking "Save New Entry."

Once your entries start to build up, it's time to take advantage of Buttercup's password-filling features. Look for the Buttercup logo appearing next to login boxes in your browser—click this and you should see the relevant username and password appear, enabling you to click to quickly populate the boxes. Alternatively click the "..." button to reveal options to copy username or password to the clipboard, plus reveal the password behind its mask. If you're signing up to a website for the first time, right-click inside the password field, and choose "Buttercup → Generate password" to create a strong random password.

When it comes to mobile use, iPhone users can configure Buttercup in the same way as Strongbox (see boxout on previous page) to automatically fill passwords in any app as well as your browser. While a little rough around the edges, Buttercup has most bases covered, but if you want the best of all worlds—and are prepared to work for it—read on.

SECURE WITH BITWARDEN

Our final solution is our current go-to password manager: Bitwarden (https://bitwarden.com). This open-source multi-platform offering is the closest to LastPass and its ilk, and works in a similar way, with your passwords hosted on its own servers by default. But what sets it apart is the fact it's possible—if tricky—to host your own Bitwarden server, so all your passwords are stored on a trusted device at home.

The official guide for installing a full-blown self-hosted Bitwarden installation is found at https://help.bitwarden.com/article/install-on-premise/—but this is geared toward large organizations, and comes with some overblown system requirements. It's also a complicated setup, but thankfully some enterprising folk have developed a prebuilt version. Bitwardenrs is written in Rust, and is both relatively simple to set up (at least initially) and undemanding on your system: 10MB RAM and negligible impact on your CPU.

For this to work, you need to employ the services of Docker. Ideally, you'll set this up on an always-on 24/7 device—the box on the left reveals how to do this on a QNAP or Synology NAS—but you can also install it on your PC. You need a 64-bit CPU, 4GB system RAM, and hardware virtualization enabled in the BIOS. You can run Docker on any modern version of Linux, but our instructions focus on Windows 10 (in particular, Windows 10 Pro, Education, or Enterprise 64-bit).

INSTALLATION STEPS

If your PC fits the bill, type "Windows features" into the "Search" box, and click "Turn Windows features on or off," then enable both "Containers" and "Hyper-V" before clicking "OK" and rebooting when prompted. Now install Docker Desktop via https://hub.docker.com—click to sign up for a Docker Hub account if you don't already have one. At the quick-start screen, download and install Docker Desktop for Windows (all 835MB of it). When prompted, leave the default boxes checked (Bitwardenrs/server is a Linux container) and click "OK" to complete the installation. If prompted, update

INSTALL BITWARDEN ON YOUR NAS

For Bitwarden to work effectively, you need 24/7 access to the server. Thanks to their support for Docker, both capable Synology and QNAP NAS drives are the perfect host for your new Bitwarden server. Synology users can follow the guide at www.synoforum.com/resources/bitwarden-self-hosted-password-manager-using-bitwardenrs-server-image.3/, but QNAP users need to adapt the instructions there for their own setup, as follows....

If you're using QNAP, first verify in File Station that there's a shared "Container" folder, then add a subfolder inside here called "Bitwarden." Next, open Container Station, choose "Create" and search for "bitwardenrs" then click "Install" next to the "bitwardenrs/server" entry at the top. Leave "Latest" selected and click "Next."

Give it a suitable name, then reduce the "CPU Limit" to 20 percent and "Memory Limit" to the minimum 64MB before clicking "Advanced Settings." Select "Network"—by default, NAT mode shares your NAS's IP address with Bitwarden (click "Add" under port forwarding to forward port 4000 on the host to 80 on the container); if you want to allocate it a unique IP address on your network, select "Bridge" under "Network Mode," followed by "Use static IP," and pick an unused IP.

Select "Shared Folder" and click the second "Add" button above "Volume from host." Next, click inside the "Volume from host" box to browse for the "Bitwarden" folder you created, then type "/data" into the "Mount Point" box. Click "Create," review the settings, and click "OK." To monitor the installation, select "Containers" under "Resource." Once downloaded, the Bitwarden docker appears here. Click its name to view the console as its setup and basic configuration takes place. When you see a reference to "[rocket:rocket[[INFO] GET/alive:" the server should be up and running. Open a web browser and type the IP address you allocated earlier into it, and you should find yourself at the web vault login screen, ready to continue.

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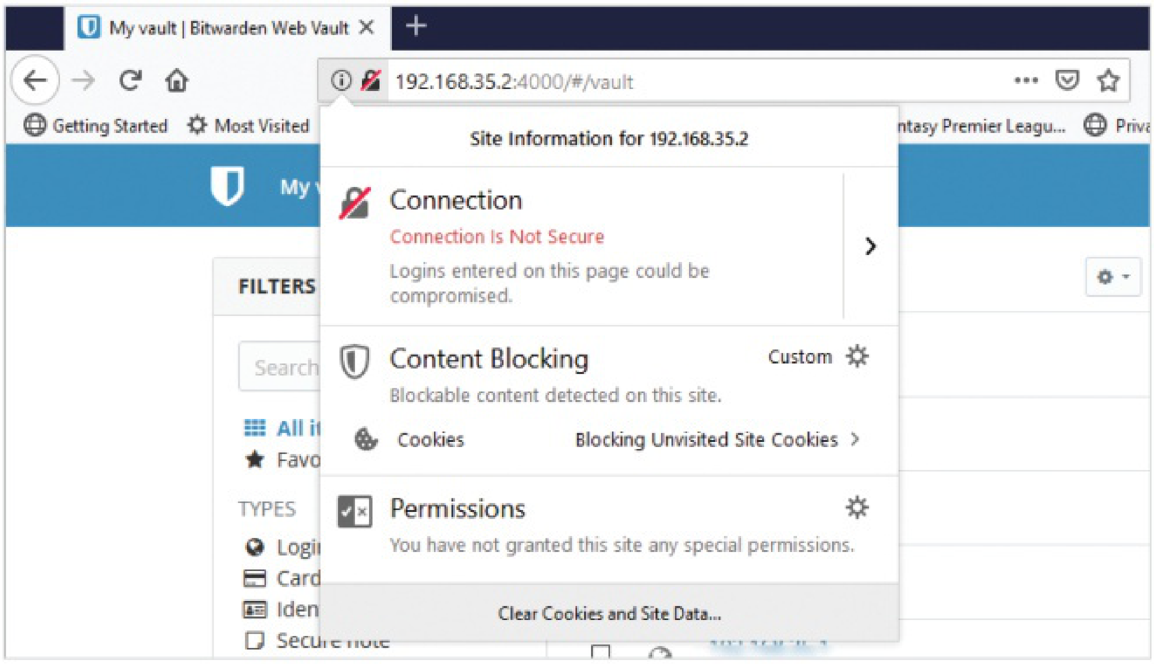

Site Information for 192.168.35.2

Connection

Connection Is Not Secure

Logins entered on this page could be compromised.

Content Blocking — Custom

Blockable content detected on this site.

Cookies — Blocking Unvisited Site Cookies

Permissions

You have not granted this site any special permissions.

Clear Cookies and Site Data...

Your Bitwardenrs server requires extra steps to make it secure.

Docker. Once done, make sure Docker is running (look for its Notification area icon), then open a Powershell window before issuing the following command:

```
$ docker pull bitwardenrs/server:latest
```

This downloads the images required to run Bitwardenrs. The next command creates a quick and dirty Bitwarden install that has no security, but works instantly:

```
$ docker run -d --name bitwarden -v /
bw-data/:/data/ -p 80:80 bitwardenrs/
server:latest
```

That's it for basic setup and configuration. If you now open a web browser on your PC or any device on your local network and type "http://192.168.x.y" (substitute "x" and "y" for your PC's IP address), you should find yourself at the Bitwarden web vault, where you can create your account and log into it. One note: Chrome refuses to connect to the web vault in this configuration (see https://github.com/bitwarden/web/issues/254).

LINK TO BITWARDEN

Assuming you're happy to access the Bitwarden server exclusively over your home network insecurely, then you're done with setup and configuration. This configuration allows you to access your vault securely when outside your home network (just don't explicitly log out of Bitwarden while on the road), but you won't be able to sync any new logins you create with the server until you're back inside your network (simply select "Settings → Sync → Sync vault now" to force a manual sync if it doesn't happen automatically for any reason).

If you want external access to the server, you first need to configure a domain to point to your Bitwarden server—one simple solution is to make use of a free dynamic DNS service, such as No-IP (www.noip.com). You also need to implement HTTPS security with an SSL certificate—see the final box for details.

In the meantime, existing Bitwarden users should start by transferring their passwords from the cloud to their new server: Log into https://vault.bitwarden.com, select "Tools," and click "Export Vault." Read the warning, leave ".json" selected, and enter your master password again before clicking "Export Vault" again. Save the file somewhere secure, then log out, and close the browser tab.

Type your server IP address along with any required port number—you should see the same interface as found at https://vault.bitwarden.com, but this is pointing to your local server. Log into your new account, and this time select "Tools → Import data." Select "Bitwarden (json)" as the import file format, then click "Browse" to select your exported file, followed by "Import." Wait while it's uploaded, and your passwords imported. Once done, you are ready to start configuring your apps and browser add-ons.

If necessary, click "Settings" to log out of your web-hosted Bitwarden account. At the login screen, click "Settings," where you'll see the fields required to access your self-hosted environment (if left blank, Bitwarden defaults to its online servers). You only need to fill the top field: Enter "http://192.168.x.y:4000" or whatever your IP address/port number combo is, click "Save," and log in as normal.

From here, Bitwarden should largely behave as normal—we recommend visiting "Settings → Two-step login" in the web vault to set up 2FA using an authenticator app such as Google Authenticator or Authy for extra security, but otherwise you're done. You have the flexibility of an online password manager with the security of knowing exactly where your passwords are stored. ⏻

SECURE YOUR SERVER

The basic Bitwardenrs server is up and running, but there are key elements missing: One, there's no security, and two, you can't access the server outside your local network. To see what's required, visit the Bitwardenrs wiki (https://github.com/dani-garcia/bitwarden_rs/wiki). The best solution is to use a third-party certificate such as Let's Encrypt, but it's complicated to set up—start your search at https://blog.linuxserver.io/2019/01/15/self-hosting-bitwarden/.

If, however, you're not intending to use Bitwarden on your iPhone or Android, you can generate your own self-signed certificate as outlined in the wiki (see "Using a Private CA and making SSL certs work with Chrome") in conjunction with the domain name you're using to point to your server.

This involves OpenSSL, and Windows users must first download and install the full version of Win64 OpenSSL (https://slproweb.com/products/Win32OpenSSL.html)—choose Win32 OpenSSL and adapt the commands below if you're running Bitwardenrs on Windows 32-bit.

Once installed, type "environment" into the "Search" box. Click "Set the system environment variables" followed by "Environment Variables." Click "New" under "System variables," name it "OPENSSL_CONF" and click "Browse File" to select "C:\Program Files\OpenSSL-Win64\bin\openssl.cfg." Once created, select "Path" under "System variables" and click "Edit" followed by "New" to insert "C:\Program Files\OpenSSL-Win64\bin\." Click "OK." You should now be able to open a Command Prompt window, navigate to a suitable location (such as "C:\keys"), then issue the commands listed to create the required keys. When generating the "Bitwarden.ext" file, substitute "Bitwarden.local" with your own domain name.

Next, switch to the "Enabling HTTPS" section of the wiki for additional steps to follow—if you're running Bitwardenrs on a NAS, visit www.synoforum.com/threads/378/ (Synology) and https://github.com/dani-garcia/bitwarden_rs/issues/465 (QNAP) for more help with setting things up.

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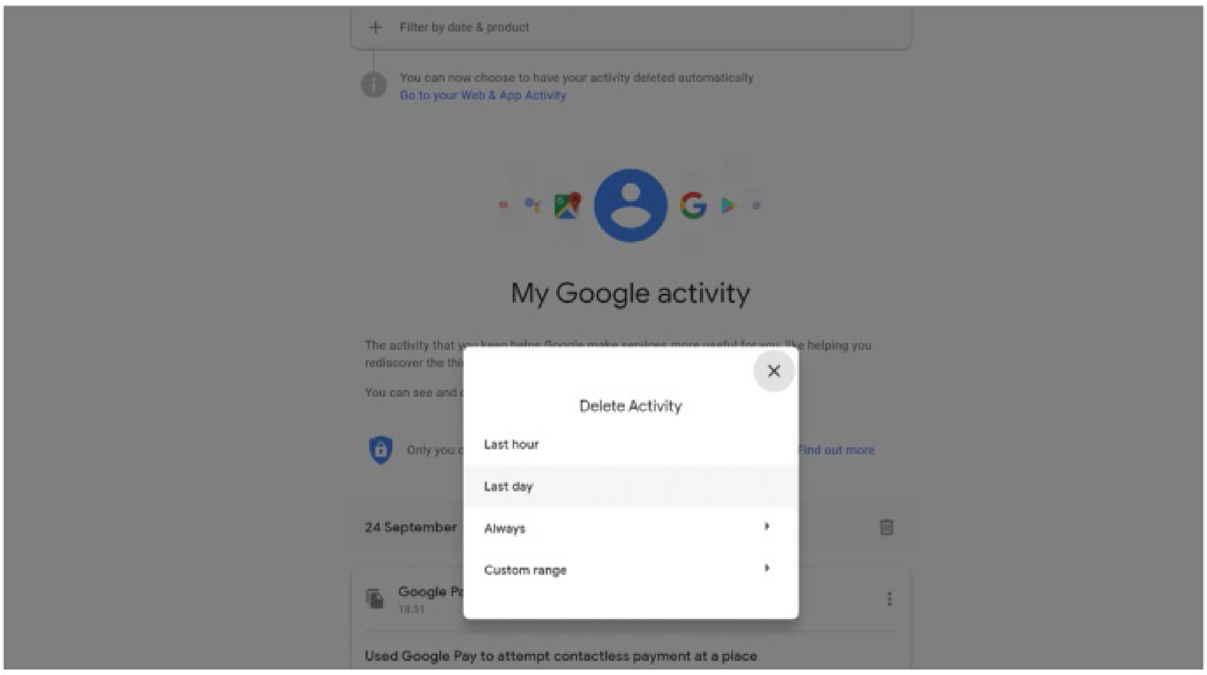
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



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CLEAR GOOGLE ASSISTANT RECORDINGS

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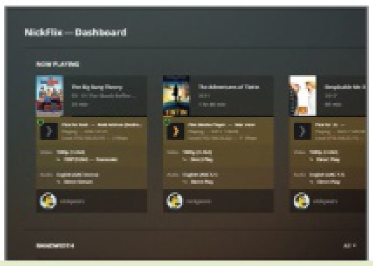
MAKE – USE – CREATE



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Avoid excessive transcoding when using Plex

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Discover some invaluable Windows shortcuts

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Explore Affinity Photo's range of Personas

CHRISTIAN GUYTON
STAFF WRITER

RIPPING THE THREADS

Information is still thin on the ground regarding the upcoming Threadripper 3000 series of CPUs, but we know AMD is ready to go big: The high-end 3970WX and 3990WX chips rock an almighty 64 cores and 128 threads. Plus, a recent leak mentioned "dual socket support." Two Threadrippers on one TR4 motherboard? Oh my. The same leak also mentioned a "Black Edition" of the 3990WX, available with a special-edition NZXT case.

We don't have any news on base or boost clocks, but a base of 5.0GHz wouldn't be untoward on the higher-spec CPUs. The pricing is also unknown, but the $1,799 price tag on the 2990WX provides some idea; they won't be cheap.

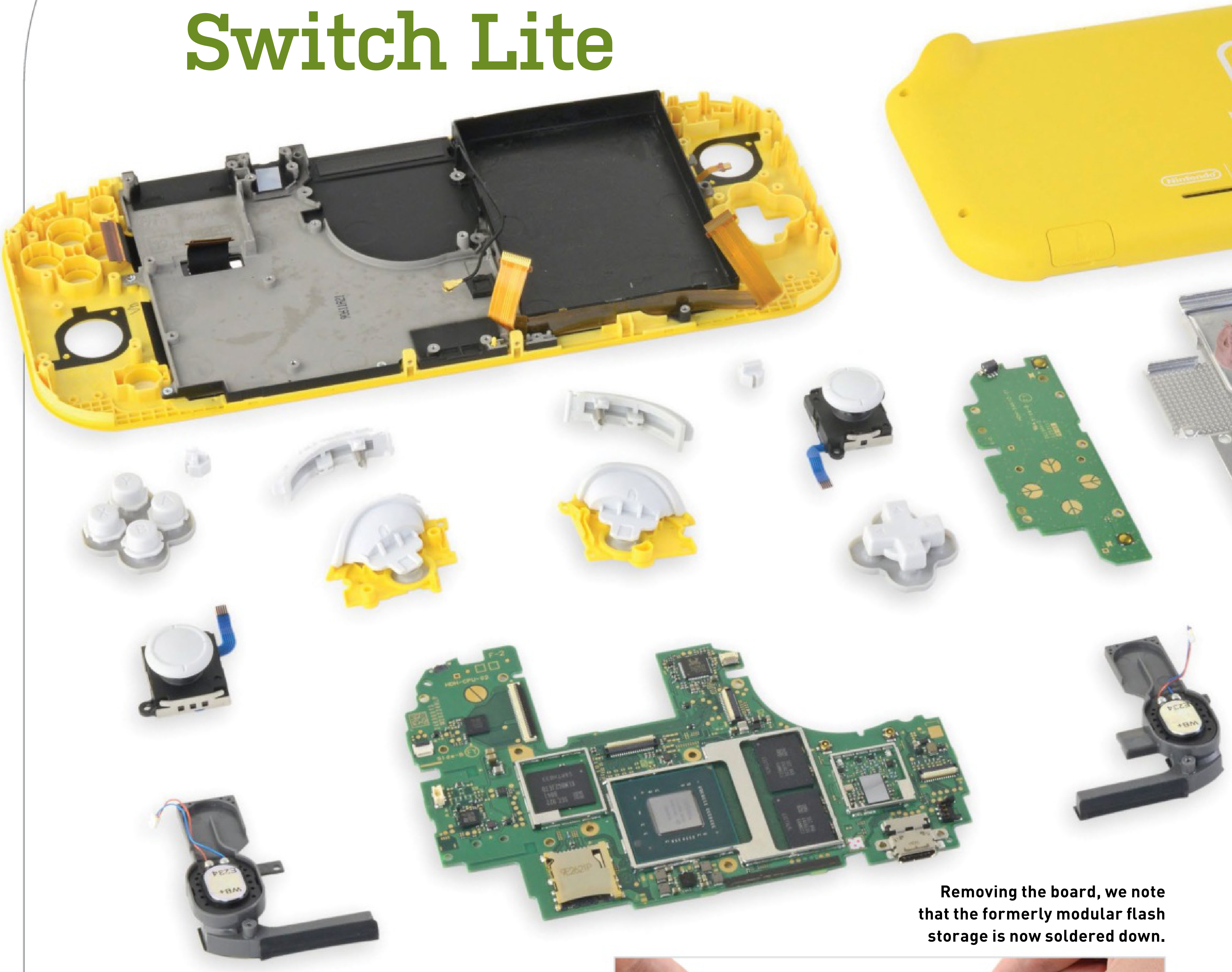
Intel does have a response—sort of. While it's not offering dual-socket wizardry, its leading CPU is getting an upgrade. The i9-9900KS is effectively a binned version of the i9-9900K; cherry-picking the best chips to produce a new HEDT standard. It'll demand serious cooling, but its eight cores can hit a simultaneous 5.0GHz turbo clock. Promising, but hardly revolutionary. While Ice Lake might have hit laptops, 10nm HEDT processors from Intel still look like a distant dream, leaving the field wide open for AMD to seize the throne.

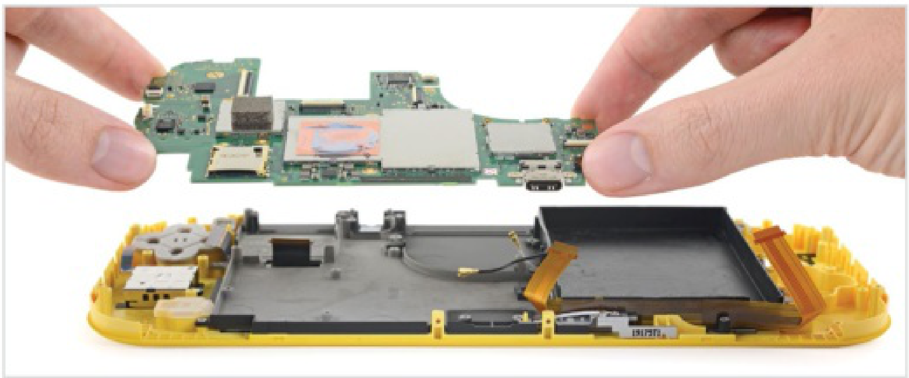
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents: AUTOPSY

THIS MONTH WE DISSECT...

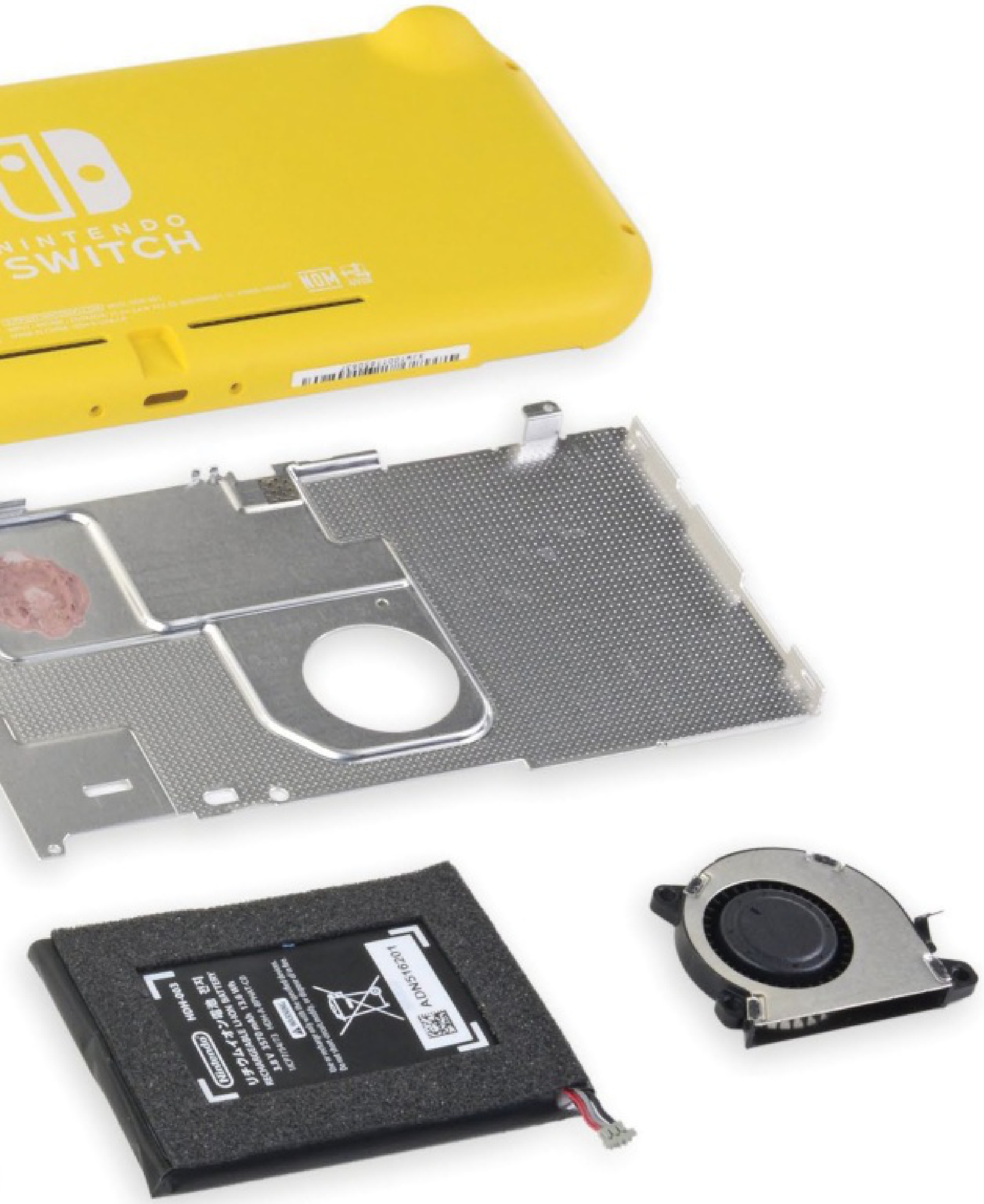
Nintendo Switch Lite





Removing the board, we note that the formerly modular flash storage is now soldered down.

About iFixit iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



This is what we're tearing down today: the bright yellow, brand new Nintendo Switch Lite.

BACKGROUND

There's a new Switch on the block: the Nintendo Switch Lite, and it comes with less in order to cost you less. It also arrives in some hot new colors.

MAJOR TECH SPECS

- Built-in 5.5-inch 1280×720 capacitive touchscreen LCD
- Custom Nvidia Tegra processor
- 32GB of internal storage (up to 2TB additional storage via microSDHC or microSDXC card)
- 802.11a/b/g/n/ac Wi-Fi, Bluetooth 4.1, NFC, USB Type-C port (charging only), and 3.5 mm audio jack
- Built-in accelerometer and gyroscope
- Rechargeable 13.6Wh lithium-ion battery
- Evolved with undetachable controllers

KEY FINDINGS

- We yanked really hard on the controls in the hope of scoring two new bright yellow Joy-Cons, but alas, they don't detach. A more traditional disassembly is required.
- The way is blocked by impassable tri-point screws. Under the back cover, we find another cover. Moving on, the SD card reader is now permanently attached to the main board—on the old Switch, we'd already removed it by now. Modularity is good for repair, so this is a step backward. Let's peek under the metal shield to look at the internals.
- We blow the cover off our revised-for-2019 Switch and do some Lite comparisons. Most important change: The battery in the Lite is no longer upside-down. It's also smaller and sits next to a lighter-gauge heat pipe, while the headphone jack has gone fully modular.
- More efficient hardware makes for longer battery life (three to seven hours, according to Nintendo) and less waste heat, so we're unsurprised to see a downsized heatsink and fan. Another slight difference: The previous L and R triggers pressed directly against a button on a PCB, but the new triggers switch to a membrane-style key.
- Pulling aside a dedicated mini -Joy-Con board, we get to a source of controversy in the Switch—the joystick. Initially, these joysticks look similar to the 2019 Switch joysticks—but the design of the clasps around the edges is different, and the case is easier to open. Inside, there's some new trace routing, a narrower stick click button, and wider-looking metal sliders. A guess at the cause of joystick drift is that the contact pads under the sliders wear down.
- The original Switch had a non-laminated, air-gapped display, making for cheap and easy screen repairs, so how does the Switch Lite fare? A little heat and prying is all it takes to coax the display assembly from the frame, and with a bit more convincing, the digitizer/screen separates from the display. Success!
- Repairability score: 6 out of 10 (10 is easiest to repair). Screws, rather than adhesives, secure most components. Many components, including joysticks, fan, and headphone jack, are modular and can be replaced independently. The battery, though strongly glued down, can be replaced after removing the rear case. The digitizer and display are not fused, but firmly glued in place. The flash storage and SD card reader are now soldered directly to the motherboard. Uncommon tri-point screws hinder all repairs.

Avoid Excessive Transcoding in Plex

YOU'LL NEED THIS

PLEX MEDIA SERVER

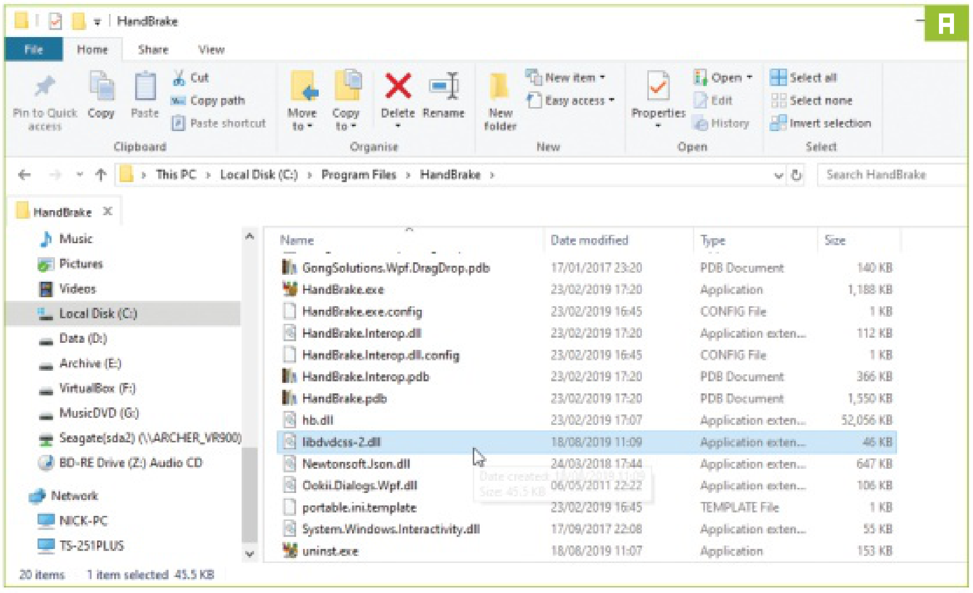
Get this from www.plex.tv if you're building your first media server.

HANDBRAKE

Head to https://handbrake.fr to download your copy.

THE BANE OF ANY MEDIA server's life is the need to transcode. Imagine this: You've converted your movies to one format already, only for your media server to waste precious CPU cycles converting it to a format that can be played back on your target device. Sometimes this process is inevitable—you want to watch a 1080p HD movie on an older 720p screen, for example—but in most cases, you should be looking to minimize the need to transcode. You'll not only reduce the load on your server (allowing it to serve multiple streams simultaneously without breaking a sweat), but often you'll make things easier for your playback devices, too.

But how do you go about avoiding the need to transcode unnecessarily? First, you need to prepare your media so it's in the most universal format possible. We'll show you the settings you need to convert great video that will play on the widest possible devices natively. We'll also reveal how to optimize your server and playback devices to avoid unnecessary transcoding, too. Our media server of choice is Plex, but the techniques and tips below can be translated to cover your own specific media server. **–NICK PEERS**


A
HandBrake
File
Home
Share
View
Pin to Quick access
Copy
Paste
Cut
Copy path
Paste shortcut
Clipboard
Move to
Copy to
Delete
Rename
Organise
New folder
New item
Easy access
New
Properties
Open
Edit
History
Select all
Select none
Invert selection
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This PC › Local Disk (C:) › Program Files › HandBrake ›
Search HandBrake
Music
Pictures
Videos
Local Disk (C:)
Data (D:)
Archive (E:)
VirtualBox (F:)
MusicDVD (G:)
Seagate(sda2) (\\ARCHER_VR900)
BD-RE Drive (Z:) Audio CD
Network
NICK-PC
TS-251PLUS
20 items 1 item selected 45.5 KB

Name	Date modified	Type	Size
GongSolutions.Wpf.DragDrop.pdb	17/01/2017 23:20	PDB Document	140 KB
HandBrake.exe	23/02/2019 17:20	Application	1,188 KB
HandBrake.exe.config	23/02/2019 16:45	CONFIG File	1 KB
HandBrake.Interop.dll	23/02/2019 17:20	Application exten...	112 KB
HandBrake.Interop.dll.config	23/02/2019 16:45	CONFIG File	1 KB
HandBrake.Interop.pdb	23/02/2019 17:20	PDB Document	366 KB
HandBrake.pdb	23/02/2019 17:20	PDB Document	1,550 KB
hb.dll	23/02/2019 17:07	Application exten...	52,056 KB
libdvdcss-2.dll	18/08/2019 11:09	Application exten...	46 KB
Newtonsoft.Json.dll	24/03/2018 17:44	Application exten...	647 KB
Ookii.Dialogs.Wpf.dll	06/05/2011 22:22	Application exten...	106 KB
portable.ini.template	23/02/2019 16:45	TEMPLATE File	1 KB
System.Windows.Interactivity.dll	17/09/2017 22:08	Application exten...	55 KB
uninst.exe	18/08/2019 11:07	Application	153 KB

1 TOOLS OF THE TRADE

When it comes to converting or ripping your media in a universal format, there's no better tool than Handbrake, the brilliant open-source transcoder for Windows, Mac, and Linux. If you plan to rip from DVD, you can do so directly from within the program once you've installed a library called "libdvdcss."

» Windows users need to download this file: http://download.videolan.org/pub/libdvdcss/1.2.11/win64/libdvdcss-2.dll (substitute "win32" for "win64" in the URL if you're running the 32-bit version of Handbrake). Save it to your "Downloads" folder, then copy it to "C:\Program Files\Handbrake" [**Image A**]—you need administrator access to do this, which is why you can't download directly to the "Program Files" folder. Job done.

» Linux users should visit www.videolan.org/developers/libdvdcss.html for instructions on obtaining the latest version. MacOS users should open a Terminal window and issue the following three commands, following the prompts to install Xcode and Homebrew:

```
$ xcode-select --install
$ ruby -e "$(curl -fsSL https://raw.githubusercontent.com/
Homebrew/install/master/install)"
```

(If you get any errors about folder ownership, run the recommended command, then repeat the "ruby" command.)

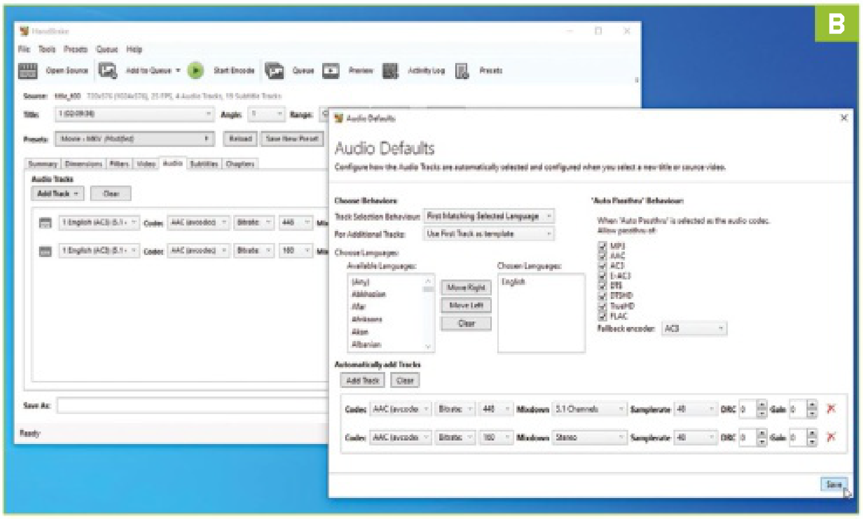
```
$ brew install libdvdcss
```

2 PICK A UNIVERSAL STANDARD

This is the most important step of the entire process: picking the file format that will play natively on as wide a range of devices as possible. Remember, video files comprise three elements: separate video and audio codecs for handling the movie's video and audio streams, plus a container to wrap them up in. Check your media server's support pages to see whether they offer any advice (Plex users can get detailed guidance at https://support.plex.tv/articles/203810286, for example).

» In most cases, however, the following options represent the closest thing there is to a universal standard: Choose MP4 for your file format (or container), using H.264 for SD/HD video, and AAC for the audio stream. If you're producing 4K content, substitute H.264 with HEVC/H.265 for the video codec.

» Plex lists several additional requirements: H.264 codecs are available in multiple versions or profiles, known as "Levels." The higher the number, the higher the supported video bit and frame rates. Plex recommends no higher than Level 4.0, which is the minimum required to support full HD. Handbrake defaults to version 4.1 for HD, and 3.1 for SD. The difference between 4.0 and 4.1 is basically one of maximum bitrates—4.1 supports 50–200Mbit/s compared to 4.0's 20–80Mbit/s. For


B
HandBrake
Audio Defaults

© PLEX MEDIA SERVER, HANDBRAKE

streaming purposes, 4.0 is more than enough, but if—like us—you've been happily ripping away at 4.1, all may not be lost, as we'll reveal later.

3

SET UP HANDBRAKE PRESETS

When you come to rip or convert video in Handbrake, you're confronted by a bewildering array of choices spread across multiple tabs. Some settings are important for compatibility purposes, while others affect the quality of the video and audio stream, plus allow you to incorporate subtitles and named chapters. While the compatibility settings remain consistent across your video streams, you may want to apply different quality settings depending on the type of media being converted (for example, TV episodes versus movies).

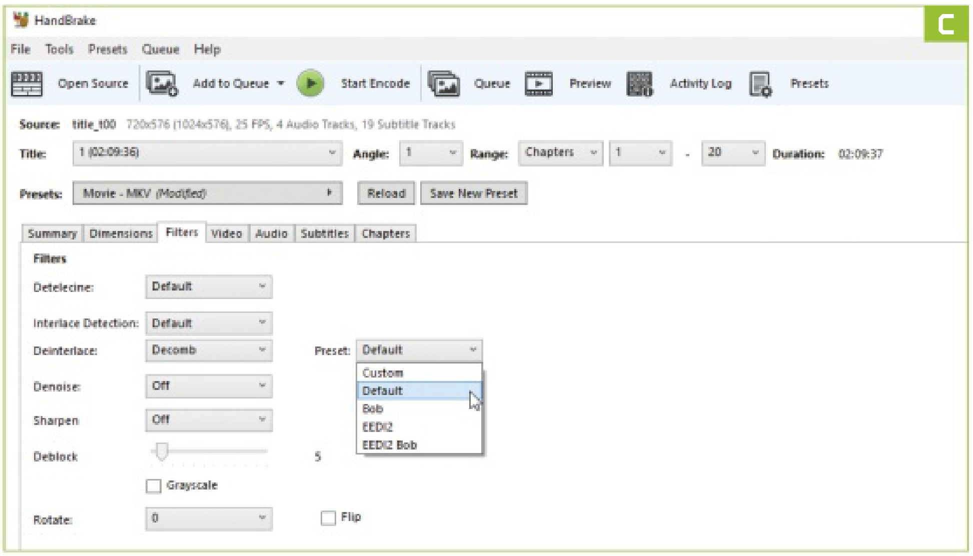
›› Rather than manually setting these up each time you convert a different type of video, Handbrake enables you to store customized settings in the form of presets. Configure your settings—when it comes to audio and subtitle settings, make sure you configure these via the "Selection Behavior" button to ensure they're stored with the preset [**Image B**]—and then choose "Save New Preset" to give them a suitable name. Be sure to select "Custom" under "Dimensions" if you've configured a specific size (such as reducing 1080p HD streams to 720p to save disk space) before clicking "Add."

›› How many presets you need is obviously up to you—for example, you may have different settings for NTSC and PAL DVD rips, or a range of UltraHD (4K) and HD settings, depending on specific movie genres (say action versus animation), or movie versus television.

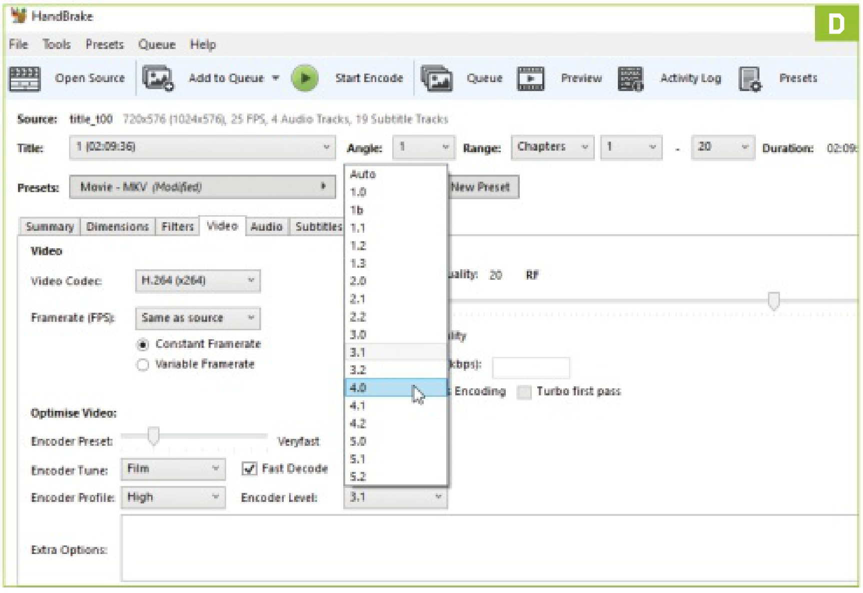
4

BUILD YOUR FIRST UNIVERSAL PRESET

Open Handbrake and choose to open a disc, folder, or file. Use the "Title" drop-down to select the video you wish to convert, then it's time to work your way through the various tabs of options.



Source: title_100 720x576 (1024x576), 25 FPS, 4 Audio Tracks, 19 Subtitle Tracks
Title: 1 (02:09:36) Angle: 1 Range: Chapters 1 - 20 Duration: 02:09:37
Presets: Movie - MKV (Modified)
Detelecine: Default
Interlace Detection: Default
Deinterlace: Decomb Preset: Default
Denoise: Off
Sharpen: Off
Deblock 5
☐ Grayscale
Rotate: 0 ☐ Flip



Source: title_100 720x576 (1024x576), 25 FPS, 4 Audio Tracks, 19 Subtitle Tracks
Title: 1 (02:09:36) Angle: 1 Range: Chapters 1 - 20 Duration: 02:09
Presets: Movie - MKV (Modified)
Video Codec: H.264 (x264)
Framerate (FPS): Same as source
● Constant Framerate
○ Variable Framerate
Quality: 20 RF
Encoder Preset: Veryfast
Encoder Tune: Film ☑ Fast Decode
Encoder Profile: High Encoder Level: 3.1
Encoding ☐ Turbo first pass
Extra Options:

›› Start with "Summary." Make sure "MP4" is selected as the format, and check both "Web Optimized" and "Align A/V Start." On the "Dimensions" tab, leave the "Width" and "Height" boxes alone, unless resizing video as outlined above. Set "Anamorphic" to "Automatic" and "Modulus" to "2," while leaving "Cropping" to "Automatic."

›› The "Filters" tab is where you can correct problems with the original source material. The "Detelecine" and "Deinterlace and Decomb" filters deal with interlacing problems that are visible as "combing" effects. These are clearly visible in older broadcast material that's converted to DVD, and should be visible in the preview on the "Summary" tab. If you need it, set "Detelecine" and "Interlace Detection" to "Default," and "Deinterlace" to "Decomb" (default preset) to cover most bases [**Image C**].

›› The other three primary filters—"Deblock," "Denoise," and "Sharpen"—should normally be left disabled, applied in extreme situations only. "Deblock" is a last-resort option for when the original video is so blocky it's unwatchable. Experiment with pushing the slider up one notch at a time, choosing the best trade-off between removing the artifacts and removing too much detail to leave the image "soft."

›› "Denoise" works to reduce grain or blur. Choose the "NLMeans" filter—it's slower than the other filter, but more effective. The "Sharpen" filter does what you'd expect, but the same rule applies to both filters: The stronger the settings, the greater the side effects. Start as low as possible ("Ultralight" or "Light") and click "Preview → Live Preview" to encode a 45-second segment of your movie to see the effects of your tweak.

5

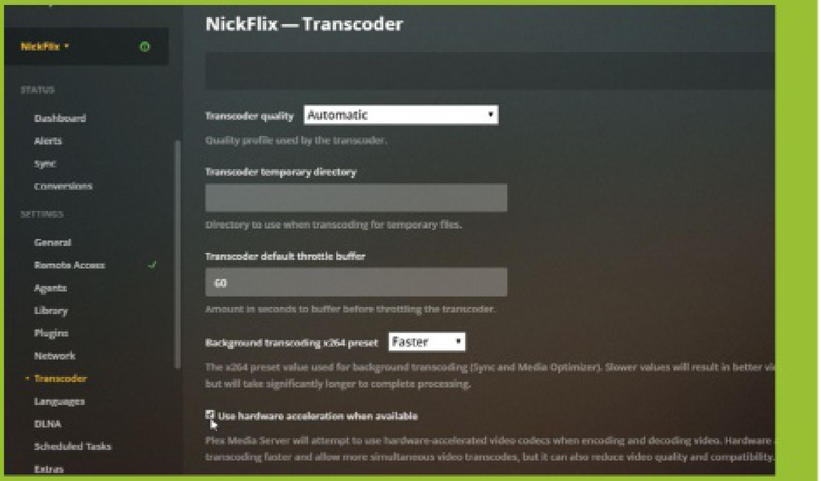
ENSURE MAXIMUM COMPATIBILITY

The "Video" tab is a key part of making sure your media adheres to Plex's direct-play recommendations. Choose "H.264 (x264)" or "H.265 (x265)" depending on your source material. Ensure "Framerate (FPS)" is set to "Same as source" and that

RIP BLU-RAYS

The libdvdcss-2.dll trick allows you to rip directly from DVD in Handbrake. But what about Blu-rays? Sadly, you can't rip directly in Handbrake; instead you need to first rip the Blu-ray to one or more unencrypted MPEG-2 files, then import them into Handbrake for conversion. Our current tool of choice is MakeMKV Beta (www.makemkv.com). You'll get a 30-day code for ripping Blu-rays; thereafter, either update to the latest version or input a new key via www.makemkv.com/forum/viewtopic.php?f=5&t=1053 (alternatively, choose "Help → Purchase" to buy a one-time code for $50). Once ripped, point Handbrake to the folder containing your files, and convert them to the smaller and universal MP4 format, following the advice in the main tutorial.

HARDWARE TRANSCODING



NickFlix — Transcoder

Transcoder quality: Automatic

Quality profile used by the transcoder.

Transcoder temporary directory

Directory to use when transcoding for temporary files.

Transcoder default throttle buffer: 60

Amount in seconds to buffer before throttling the transcoder.

Background transcoding x264 preset: Faster

The x264 preset value used for background transcoding (Sync and Media Optimizer). Slower values will result in better vi
but will take significantly longer to complete processing.

☑ Use hardware acceleration when available

Plex Media Server will attempt to use hardware-accelerated video codecs when encoding and decoding video. Hardware
transcoding faster and allow more simultaneous video transcodes, but it can also reduce video quality and compatibility.

Where transcoding is unavoidable, you'll need to either limit the number of transcoded streams to prevent your CPU being overwhelmed, or find ways of offloading all that work from software-based to hardware-based encoding. Hardware encoding is restricted to Intel CPUs that support Intel Quick Sync video, which covers most bases since 2011 (confirm your processor is supported by searching for it at https://ark.intel.com/#@Processors).

Using hardware to transcode streams means the effect on your CPU is almost as negligible as direct streaming or direct play, but before jumping for joy, be aware it may not be the magic bullet you hope it is. Hardware encoding almost always results in lower-quality streams, but how noticeable this is comes down to several factors. First is the quality of the source material—ironically, low bitrate, SD resolutions fare worse than HD and 4K movies, but in most cases, you shouldn't need to transcode these streams if you follow our guide.

Second—and ultimately more importantly—is the age and type of your processor. Older processors, such as the Intel Celeron J1900 powering our QNAP TS-251+, produce lower-quality videos using their hardware transcoding engine than newer ones—in our case, the degradation is too noticeable for us to use it.

"Constant Framerate" is selected. This should ensure your video stays within Plex's recommended 30fps and 8-bit video depth setting. In terms of quality, this has no bearing on Plex's ability to direct-play the video, but a rule of thumb is to choose "Constant Quality" and then experiment around 20–23, with a larger figure reducing the file size at the expense of quality. Again, consider experimenting with a 45-second preview clip to strike the right balance.

» The "Encoder Options" section is again largely about quality rather than compatibility, although remember that all-important "Level" setting (maximum 4.0 for HD; 3.1 for SD) [**Image D**]. We also recommend checking "Fast Decode" here to improve playback on lower-powered devices.

» When it comes to the "Audio" tab, the key option here is choosing "AAC" as your codec. From here, Plex seems happy to direct-play multi-channel (up to 7.1 in our tests) audio streams, although support for multiple audio streams enables you to provide a fallback basic stereo option—select the audio stream before playback on your target device by clicking or tapping "Audio" next to the currently selected stream. Other audio options are a matter of personal preference—we stray toward a bitrate of 160 for simple TV stereo channels, going up to 448 for surround-sound movie setups.

» When it comes to adding subtitles, one setting often applied is the foreign audio scan—this ensures that subtitles are provided when non-English languages are spoken. If you have need of this feature, now is the perfect time to "burn" them into the video feed, so they're part of the native video stream (thus reducing the need to transcode to include them later). Choose "Foreign Audio Scan" from the drop-down menu, and check both "Forced Only" and "Burn in."

» Review your settings one last time, then save your preset if necessary, before adding the title to the queue or starting the conversion process. Once complete, open the file in your media player to check it plays, looks, and sounds correct.

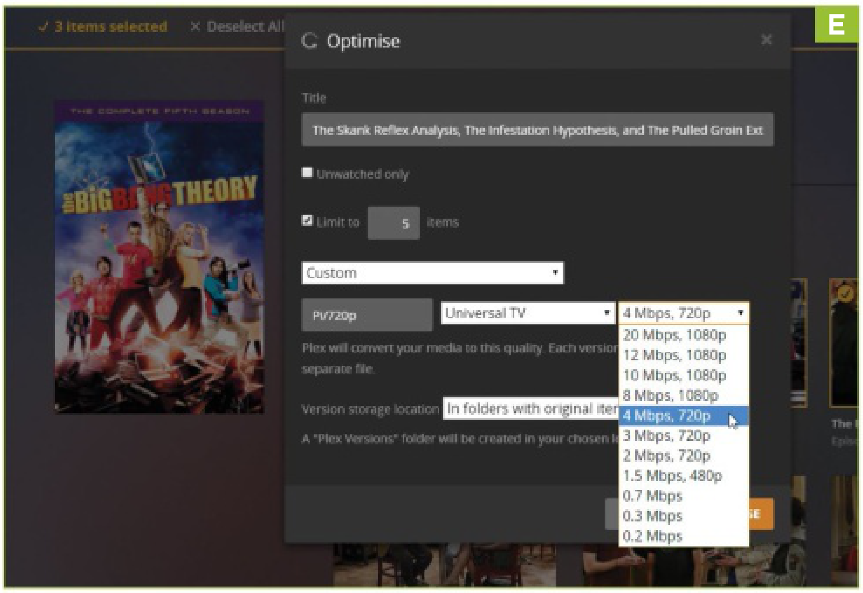
6 TWEAK PLAYER SETTINGS

You've diligently created a media library with the above universal settings, but some streams still refuse to direct-play on certain devices. There's not an awful lot you can do at the server level to force direct-play—you need to take the time to go into each player's settings and attempt to influence things from there.

» If you're accessing Plex on your browser or through the Windows or Mac app, click the "Settings" button followed by "Show Advanced." Navigate to "Debug" under "Plex" in the left-hand pane to ensure both "Direct Play" and "Direct Stream" are checked. Switch to "Quality" to verify "Use recommended settings" is checked under "Home Streaming." To minimize transcoding over the Internet, check "Play smaller videos at original quality" and set "Video quality" to "Maximum."

» It's a similar situation for mobile use: Android, iOS, and Apple TV users should navigate first to "Settings → Quality" to set similar streaming settings to above, while heading on to "Settings → Advanced" to make sure "Allow Direct Play" has been enabled. Android users should also tap "Settings → Advanced → Player" to view the "H264 Maximum Level." Remember, the app should direct-play all content encoded with all versions up to and including the maximum level specified.

» If you attempt to set the maximum level to a higher setting on your device, you'll get a warning that it may cause issues—but don't let that stop you. On our Android phone, the recommended setting was 4.0, but we were able to bump it up to 4.1, at which point a 1080p movie



Optimise

Title: The Skank Reflex Analysis, The Infestation Hypothesis, and The Pulled Groin Ext

☐ Unwatched only

☑ Limit to 5 items

Custom

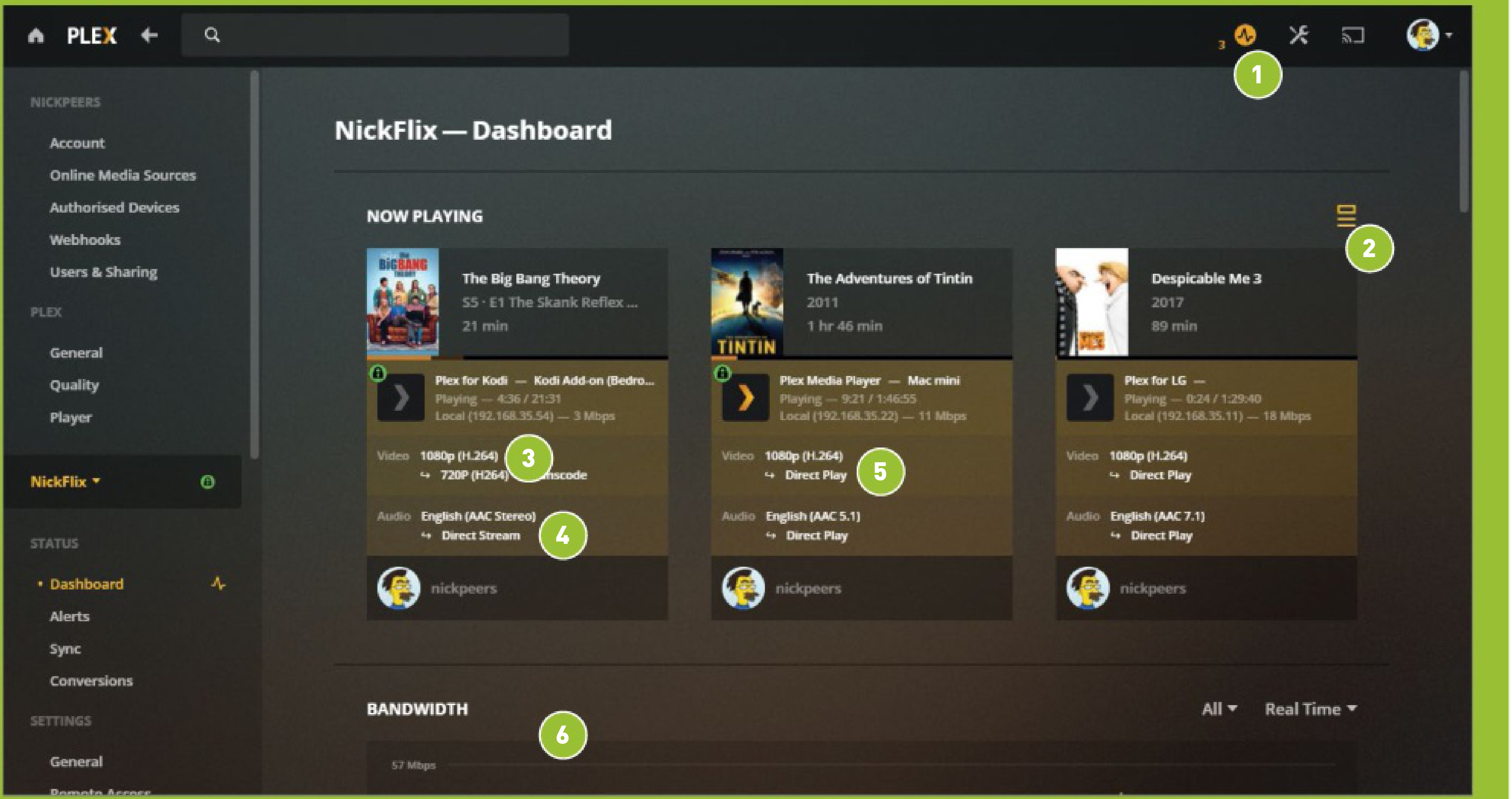
Pi/720p | Universal TV | 4 Mbps, 720p

Plex will convert your media to this quality. Each version
separate file.

Version storage location: In folders with original iter

A "Plex Versions" folder will be created in your chosen l

HOW TO MONITOR TRANSCODING ON PLEX


PLEX
1
NICKPEERS
Account
Online Media Sources
Authorised Devices
Webhooks
Users & Sharing
PLEX
General
Quality
Player
NickFlix
STATUS
Dashboard
Alerts
Sync
Conversions
SETTINGS
General
Remote Access
NickFlix — Dashboard
NOW PLAYING
2
The Big Bang Theory
S5 · E1 The Skank Reflex ...
21 min
Plex for Kodi — Kodi Add-on (Bedro...
Playing — 4:36 / 21:31
Local (192.168.35.54) — 3 Mbps
Video 1080p (H.264)
720P (H264) Transcode
3
Audio English (AAC Stereo)
Direct Stream
4
nickpeers
The Adventures of Tintin
2011
1 hr 46 min
Plex Media Player — Mac mini
Playing — 9:21 / 1:46:55
Local (192.168.35.22) — 11 Mbps
Video 1080p (H.264)
Direct Play
5
Audio English (AAC 5.1)
Direct Play
nickpeers
Despicable Me 3
2017
89 min
Plex for LG —
Playing — 0:24 / 1:29:40
Local (192.168.35.11) — 18 Mbps
Video 1080p (H.264)
Direct Play
Audio English (AAC 7.1)
Direct Play
nickpeers
BANDWIDTH
6
All
Real Time
57 Mbps

1. VIEW ACTIVITY
Open the web interface (or the Plex app on your PC or Mac), and click the "Activity" button, choosing "Dashboard" from the drop-down menu.

2. START PLAYBACK
Start playing media on a target device and then check the "Now Playing" section. Click the "Show Details" button to see which videos are direct-playing and which ones aren't.

3. TRANSCODING
If the original stream isn't compatible, your server must produce a working version on the fly, putting pressure on its CPU.

4. DIRECT STREAMING
This occurs when the stream is compatible, but either the file container isn't supported, or the other stream requires transcoding. It has little impact on your server's CPU.

5. DIRECT PLAY
The Holy Grail of streaming—your client can play the file in its original form, which means the server has no additional work to do other than serve the stream.

6. REVIEW BANDWIDTH
Some playback-related issues may occur when your network or Internet connection is saturated by multiple streams vying for available bandwidth.

ripped with the H.264 Level set to 4.1 direct-played perfectly instead of transcoding (poorly). At the same time, the server's CPU load dropped from 60 percent to 5 percent.

›› Most smart TVs—plus Plex for Roku and also the Plex add-in for Kodi (which we use on a Raspberry Pi 3 running LibreElec)—share a similar web-wrapped user interface, so the following settings should be broadly similar across all devices. Click your user account name at the top of the screen and choose "Settings → Video tab." Set "Local, Remote, and Online" to "Original" and verify "Allow Direct Play" and "Allow Direct Stream" are both checked. If supported, you'll find the "Maximum H.264 Level" setting here, too.

›› If you're serving 4K content, you should also find "Allow 4K" and "Allow HEVC (h265)" options on compatible devices. If you're confident your playback device can handle it, check both of these, too, to avoid transcoding.

7 CREATE OPTIMIZED VERSIONS

Sometimes transcoding appears to be inevitable—for example, trying to play a 1080p movie on a 720p screen. Plex users can pre-empt these problems by having the server pre-transcode content based on your chosen settings, which is then served to those devices that can't direct-play the original file.

›› To set this up, open the Plex app or web interface and navigate to the content you want to serve. Select one or more items using the check box at the upper-left of the episode or movie title, then click the "…" button and choose "Optimize." You'll see a drop-down currently set to "Optimized for Mobile"—click this and choose "Custom." Use the middle drop-down to select the target device type, then use the right-hand menu to choose a bitrate and resolution that you're confident will direct-play on your target device [Image E]. Give your preset an easily identifiable name, leave these converted files in the same folder as the originals, and click "Optimize."

›› You can follow the progress of the optimization—how long it takes depends on the power of your server. Once done, your player should detect the optimized version and attempt to play it directly. You can manage these optimized versions via "Settings → Optimized Versions" (look under "Manage")—delete them all to free up space, or select one to perform additional actions, including editing the optimization further. ⏻

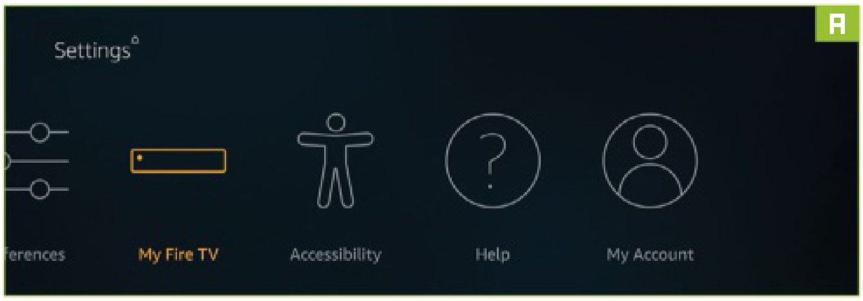
© PLEX MEDIA SERVER, HANDBRAKE

Install Kodi on a Fire TV Stick

YOU'LL NEED THIS

AN AMAZON FIRE TV DEVICE
Any will do, from the original to the 4K.

THIS WILL COME as no surprise: Amazon's hardware line, ostensibly running its own OS, borrows heavily from Android. As in, it's basically a reskinned Android, with the Google apps trashed in favor of ones that support Amazon's ecosystem. This is true of the company's Fire tablets, it was true of its disastrous phone, and it's also true of the Fire TV range—it's all Android underneath. This means it has, at least to some extent, the same extendable structure as Android. We can take a Fire TV Stick or TV Cube beyond its standard lineup of channels and apps—we're not stuck with what Amazon offers on its tightly controlled store. Things like Plex are already available there in a couple of clicks, but if you're running a Kodi server at home, or if you have a passing interest in the (sometimes questionably legal) successor to XBMC, you'll know how useful having access to the Kodi app is, particularly given the TV Stick's convenient remote. This isn't only a way to run Kodi—it gets you access to a whole host of unsigned apps—but that's what we'll focus on here. Feel free to do your own experimentation. **–ALEX COX**



1

HOOK IT UP

Start by getting your Fire TV Stick prepared. It's remarkably simple, and there's no need to do any real hardware hacking or rooting—like many Android phones, the required options are in there already. Plug your TV Stick into your TV as normal, and get your remote ready, as you need it to work through these steps. Truth be told, there's not really a lot you need to do with your PC at this point—the entire install process can be done on-device, on-couch, in about five minutes if you follow along quickly.

2

OPEN THE FLOODGATES

Using the remote, head to "Settings" in the bar at the top of the main screen, then scroll across to "My Fire TV" [**Image A**]. There's a lot here, including the factory reset option (which may come in handy later if something goes wrong), but ignore it for now, and head to "Developer Options." Thankfully, there's none of the standard Android septuple-tapping shenanigans required to gain access here—Amazon has left things rather open. Just enable "Apps from unknown sources," and you've told your Fire TV Stick that you're cool with it running whatever. There's an obvious security risk here, particularly if you tinker your way into installing an app you don't trust, so we urge you to be a little careful with this new-found power. Accept the dire warning [**Image B**] and you can continue.

3

START DOWNLOADING

How do you install an unsigned app on a Fire TV Stick? In one of two ways: Either use ADB over a network (see "Easy as ADB," opposite) or download the APK file to your stick and run it from there. The non-stick version of the Fire TV, with its USB port, offers another obvious route to installation, but we'll work with the TV Stick for now. Head to Amazon's search bar and find the app Downloader; ensure it's the one published by Troypoint.com. You can also do this on your PC, picking up the app from the Amazon store, and sending it to your device, but you might as well sit and use the remote.

4

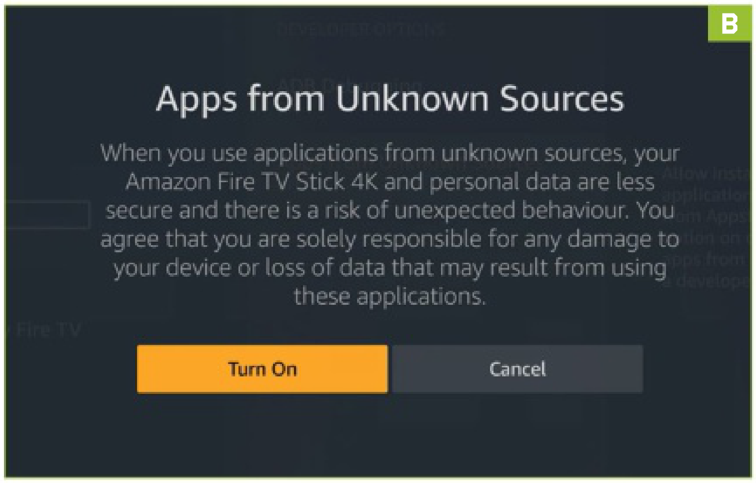
FIND KODI

Run Downloader, accept its permissions (if you don't, you won't be able to download anything), then laboriously use Amazon's infuriating alphabetical-order keyboard (seriously, why?) to type in the address of the site that hosts your desired file using the box on Downloader's "Home" screen [**Image C**]. In this case, we'll opt for the official Kodi download page at http://kodi.tv/download. This opens the page in Downloader's built-in web browser. Use your remote to control the red circle and scroll through until you find the "Android" section, then select it.

5

INSTALL KODI

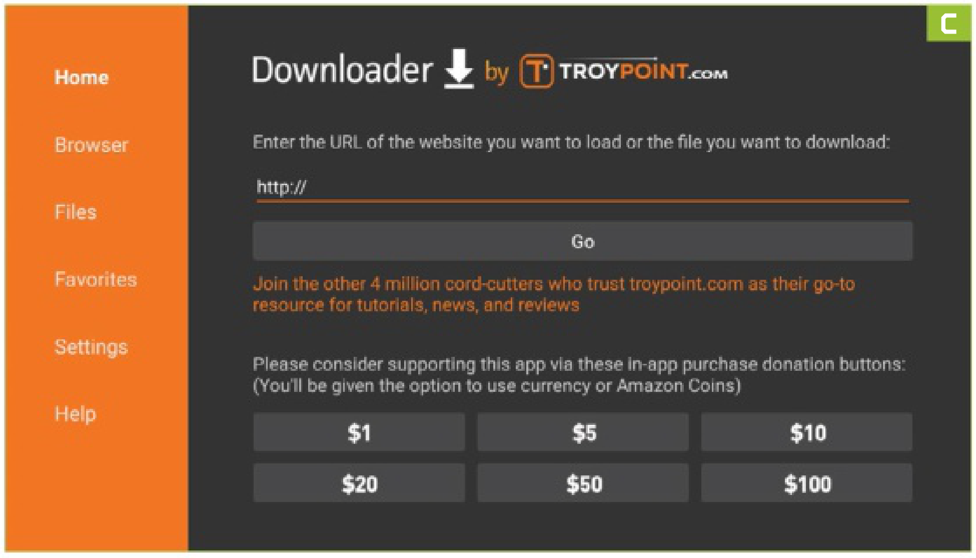
We've found the 32-bit ARM version, from the more stable "Release" branch, works best. You're welcome to try any of the others—Google Play and X86 won't work, as you're not on a Google device and you're not using an X86 chip—but the nightlies, if you're offered any, may include new experimental features to go along with the inherent instability of using bleeding-edge software. Pick your poison, download it [**Image D**], and you're given the option to install. Go ahead and do it, then select the option to remove the file you've downloaded.



Apps from Unknown Sources

When you use applications from unknown sources, your Amazon Fire TV Stick 4K and personal data are less secure and there is a risk of unexpected behaviour. You agree that you are solely responsible for any damage to your device or loss of data that may result from using these applications.

© AMAZON, XBMC FOUNDATION



Enter the URL of the website you want to load or the file you want to download:

http://

Join the other 4 million cord-cutters who trust troypoint.com as their go-to resource for tutorials, news, and reviews

Please consider supporting this app via these in-app purchase donation buttons: (You'll be given the option to use currency or Amazon Coins)

6 SKODI KODI

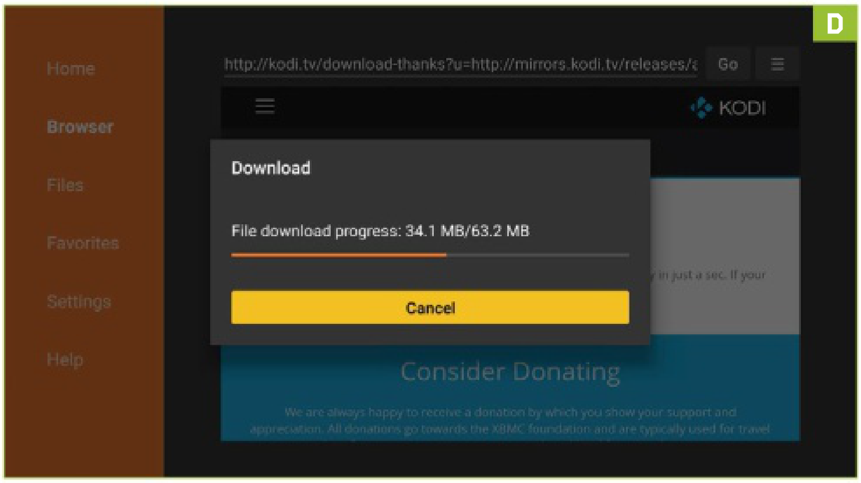
Run Kodi, work through its permissions (knowing that failing to accept some of them may well impact its ability to work at all), and you're in—thankfully, without any of the trappings of an app ostensibly developed for smartphones and tablets. It works perfectly with the remote, and you can now connect to any network media libraries you already have set up. You're also free to install your own add-ons [**Image E**] as you would be with any other Kodi client. We'll sidestep telling you how to add your own custom add-on repositories, given that they're usually cesspits of piracy, but it's possible to do so if you wish to extend Kodi's capabilities further.

7 MORE THAN KODI

Why stop at Kodi? With Downloader on board, and your device unlocked, you're able to do whatever you like beyond the offerings of Amazon's rather limited app store. Try a VPN to reach region-locked content; some, such as NordVPN, are available direct from Amazon, while others, such as ExpressVPN, are best installed via their Android app. Try the Android version of VLC if you're interested in slightly more down-and-dirty streaming of your network media. Dig around for APKs (those being Android packages) and install some games. And if anything doesn't play nice with the remote (when you're experimenting with Android apps, that's likely to be quite a lot), Mouse Toggle is a pretty essential extra. Open Downloader and head to http://tinyurl.com/firetvmouse to get it—once it's installed, you'll be able to double-tap the play button on your remote to bring up a mouse cursor, which is controllable by the arrow buttons.

8 REMOTE OR ROOT

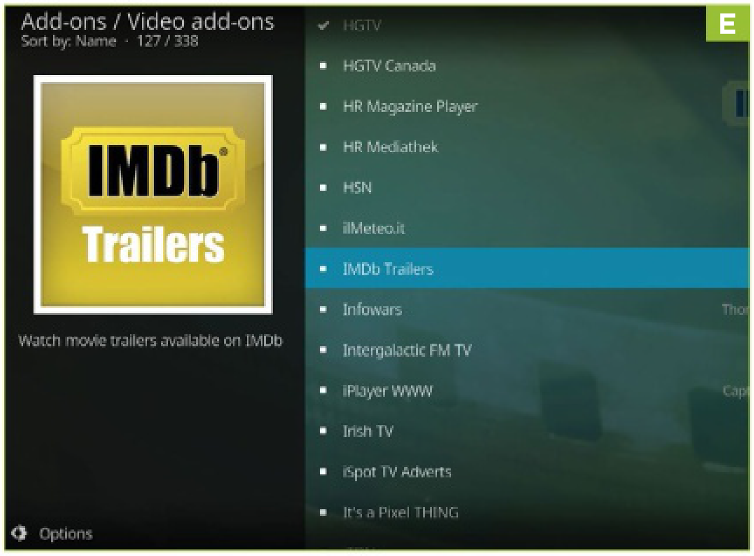
If you want to take this to the extreme, you can use your ability to sideload apps to see what's happening on your Fire TV Stick through your PC, essentially giving you easy remote access. TeamViewer itself requires Google Play Services, but its QuickSupport cousin works fine—use Downloader to grab it from https://download.teamviewer.com/download/TeamViewerQS.apk, and run it. You'll note it asks for a number of permissions in order to interact with content. We can't, at least by default, grant these, so you'll only be able to see what's going on without interacting. To actually gain full control, you'll need to have root access to your Fire TV Stick, something that is only possible on certain devices, and even then the methodology is different for every one—check http://aftvnews.com/root/ for the appropriate guide for your device, while we sit here with our Fire TV Stick 4K and weep at its unrootable nature. ⏻



http://kodi.tv/download-thanks?u=http://mirrors.kodi.tv/releases/

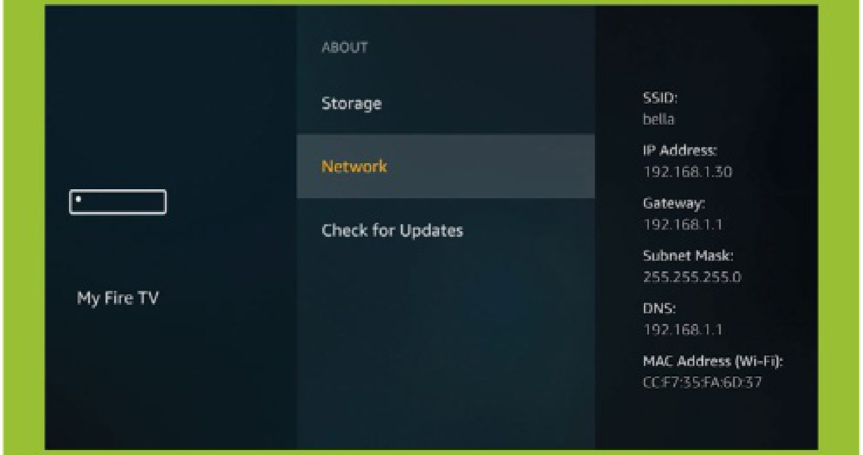
File download progress: 34.1 MB/63.2 MB

We are always happy to receive a donation by which you show your support and appreciation. All donations go towards the XBMC foundation and are typically used for travel



Watch movie trailers available on IMDb

EASY AS ADB



SSID: bella
IP Address: 192.168.1.30
Gateway: 192.168.1.1
Subnet Mask: 255.255.255.0
DNS: 192.168.1.1
MAC Address (Wi-Fi): CC:F7:35:FA:6D:37

If you want to get finer control over your Fire TV Stick, ADB, or Android Developer Bridge, is the way to go. As its name suggests, it's a protocol that forms a bridge between your PC and an Android device, enabling you to send files between them and pull up a shell, exposing Android's Linux origins. Actually getting it set up can be a little finicky; begin by switching on ADB debugging in the "My Fire TV" menu, then head over to the "About" section in the same menu to discover your IP address. Back on your PC, we recommend walking through Amazon's guide at http://developer.amazon.com/docs/fire-tv/connecting-adb-to-device.html to make sure you've set up everything properly. When you have a connection established, head out and download some APK files on your PC—the process of installing them is a simple case of typing `adb install <whatever>.apk` into your command prompt, then accepting the installation on the screen of your Fire TV Stick.

Discover Invaluable Windows Shortcuts

YOU'LL NEED THIS

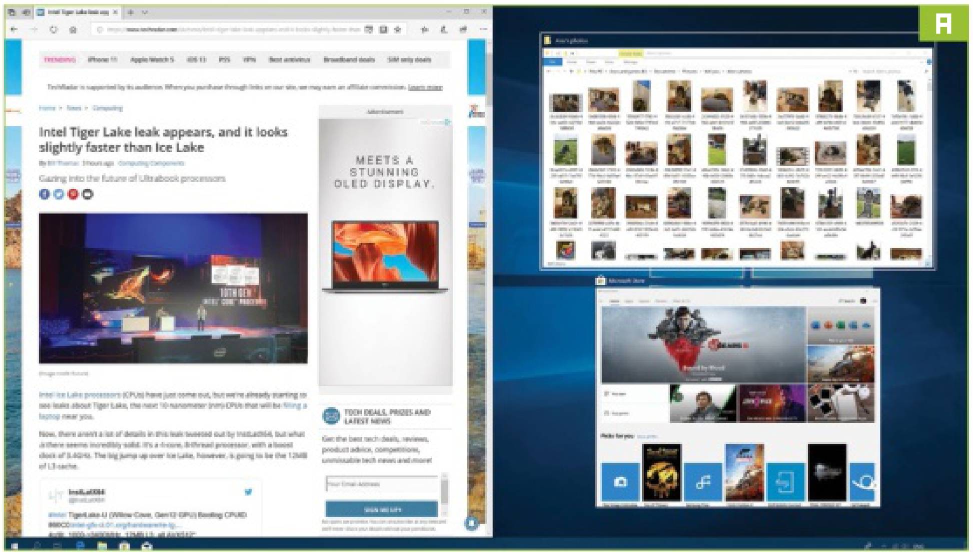
WINDOWS 10
And a keyboard with a Windows key.

USING A MOUSE IS SO 2018. These days, anyone who's anyone is using keyboard shortcuts to get things done. Not only are they so much quicker than using the mouse, but they let you impress your friends at cool bars and parties. Probably.

Anyway, most us know the standard Ctrl-C and Ctrl-V shortcuts, but Windows has a whole lot more up its sleeve when it comes to clever shortcuts. Make use of a couple of modifier keys and your keyboard suddenly becomes the launchpad of your desires (or of Windows Explorer, whichever you prefer).

For instance, the Windows key is best known for snapping you out of full-screen programs when you accidentally tap it, but did you know it has other, less annoying uses? It turns out it's actually one of the most useful keys when it comes to shortcuts. Who knew?

That's not your only option. The Ctrl, Shift, and Alt keys all unlock extra features in the apps you use most frequently. Make use of these shortcuts and you'll be a Windows workflow wizard. Who needs to use a mouse anyway? **–ALEX BLAKE**


A
Intel Tiger Lake leak appears, and it looks slightly faster than Ice Lake
MEETS A STUNNING OLED DISPLAY.
TECH DEALS, PRIZES AND LATEST NEWS

1

QUICKLY OPEN PINNED PROGRAMS

Pinning programs to the Windows 10 taskbar is a good way to quickly access the apps you use most often. But rather than using the mouse to open them, there's an even swifter way. Moving left to right, each program on the taskbar corresponds to a number. Press the **Windows** key and that number to open that program.

» For example, if you have Microsoft Edge pinned on the first spot on the taskbar, you'd press **Win-1** to open it. **Win-5** opens the program pinned in the fifth spot [**Image A**], and so on. If you press **Win-1** and already have an instance of this application open, this shortcut switches to it; press **Win-Shift-1** to open a new instance of the app.

» Alternatively, you can press **Win-T** to cycle through the programs on the taskbar, then press **Enter** to open the selected app. Or press **Win-Alt-(number)** to access the context menu for that particular program.

» Note that the **Win-(number)** tip only applies to programs—if you have the Windows 10 search icon or Task View button listed in the first spot, **Win-1** doesn't open them.

2

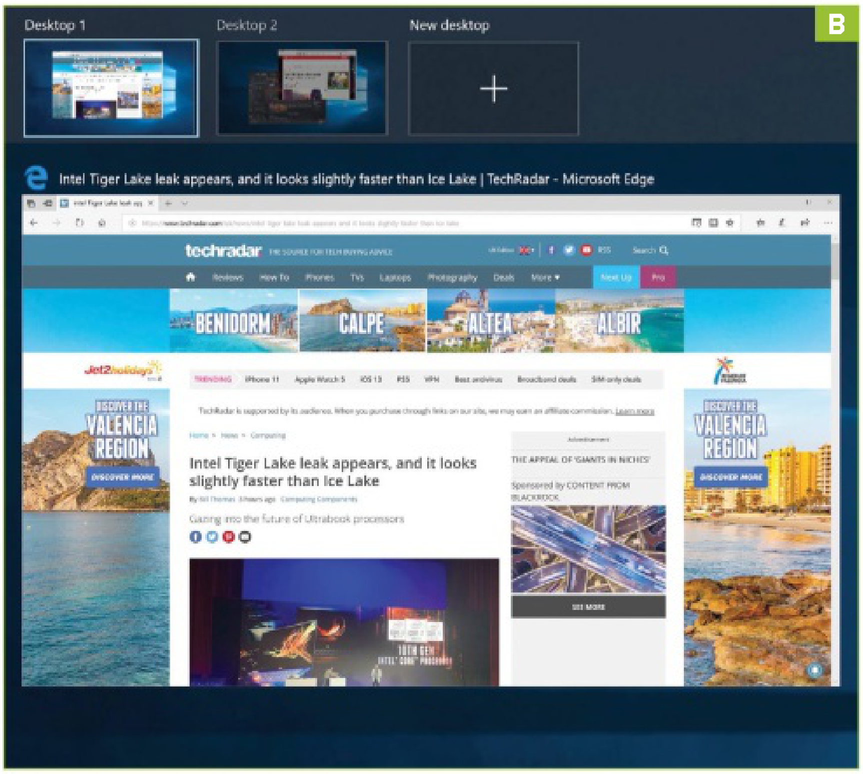
WINDOW MANAGEMENT TRICKS

Windows 10 puts plenty of handy window management tools at your disposal. For example, dragging a window to the left edge of the screen snaps it to that side, while dragging it to the top edge maximizes it. But did you know that you can do all this—and more much more quickly—with keyboard shortcuts?

» For example, you can press the **Windows** key and either the left or right directional button to snap the current window to the corresponding edge of your screen. Once you've done that, Windows presents thumbnails of your other open programs [**Image B**]—navigate through them using the arrow keys, and press **Enter** to snap one to the other side of your screen.

» The up and down arrow keys also come into play here. If your current program isn't maximized, press **Win-Up** to maximize it; press **Win-Down** to restore it to its previous size.

» And if you have additional monitors, you can quickly move programs to them without using the mouse. If you have a secondary monitor to the left of your main screen, for example, press **Win-Shift-Left** to move the current program to the left-hand display.


B
Desktop 1
Desktop 2
New desktop
Intel Tiger Lake leak appears, and it looks slightly faster than Ice Lake | TechRadar - Microsoft Edge
techradar
BENIDORM
CALPE
ALTEA
ALBIR
DISCOVER THE VALENCIA REGION
Intel Tiger Lake leak appears, and it looks slightly faster than Ice Lake

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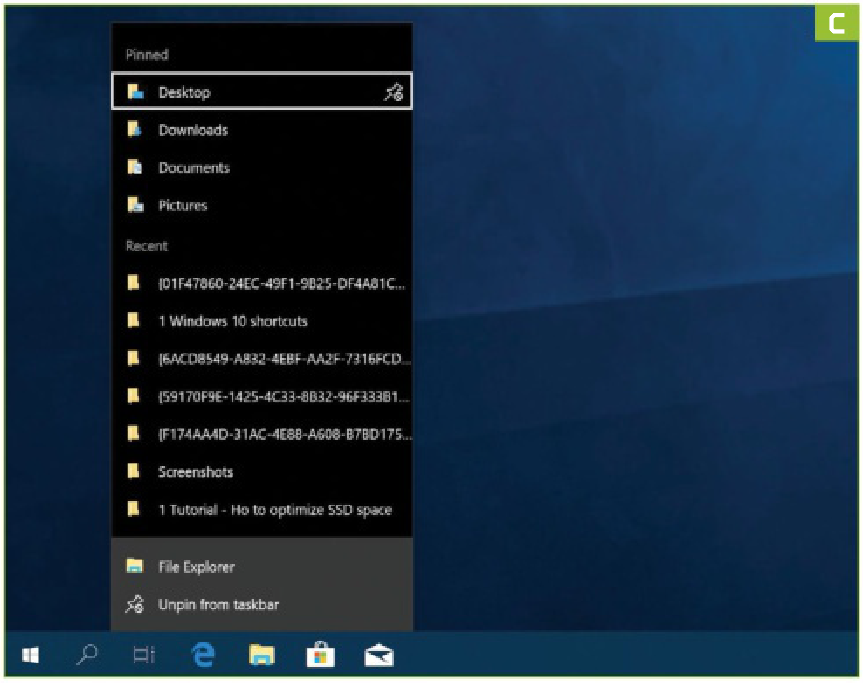
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Screenshots
1 Tutorial - Ho to optimize SSD space
File Explorer
Unpin from taskbar

3 NAVIGATE THROUGH WINDOWS

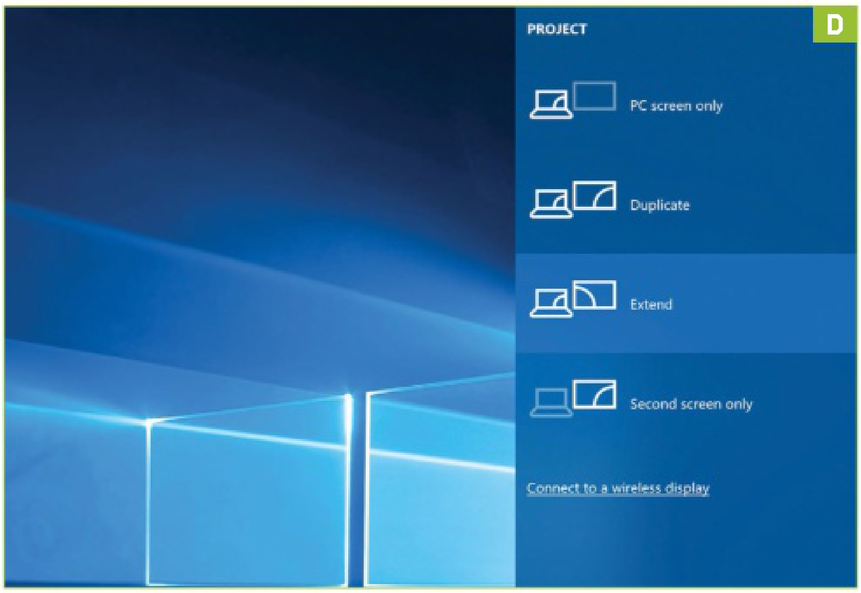
Navigating through content is much easier and quicker when you can do it through keyboard shortcuts, and these three are particularly useful. First up, press **Alt** and either the left or right arrow key to navigate backward and forward through pages or screens. This one is especially helpful because it works across programs, including Windows Explorer, web browsers, and apps such as Spotify. Because almost every program seems to put its back and forward buttons in different places, this keyboard shortcut saves you searching for them.

›› You probably know that pressing **Space** in web browsers scrolls you a certain way down the page, much like the **Page Down** key. If you accidentally press **Space** and want to get back to where you were, just hold **Shift** and press **Space** again. It's useful for those times you accidentally zip down the page and lose your place.

›› Another shortcut that's useful for undoing an action is **Ctrl-Shift-T**. Use this in a web browser and it reopens the most recently closed tab.

4 TAKE CONTROL OF YOUR DESKTOP

Now that Microsoft insists on confusingly storing Windows settings in both the Settings and Control Panel programs, you need a quick way to get to them as you embark on a wild goose chase trying to uncover where Microsoft hid the hibernation options. For the Settings program, press **Win-I** to bring it up [Image C]. For the Control Panel, your quickest option is to press **Win-R**, type **control**, then press **Enter**.



›› One underrated and very underused feature of Windows 10 is its ability to create virtual desktops. These are useful if you want to keep different tasks separate from each other—one virtual desktop for work, and another for planning a holiday, for example. To quickly create a new virtual desktop, press **Win-Ctrl-D**. Hold **Win-Ctrl** and press the left or right arrow keys to switch between desktops, and press **Win-Ctrl-F4** to close the current desktop.

›› Alternatively, if you have one desktop spread across more than one monitor, you can access Windows 10's display options by pressing **Win-P** [Image D]. This enables you to choose whether to duplicate your main display on to the secondary monitor(s), extend your main desktop, or only show content on one screen.

5 OTHER USEFUL SHORTCUTS

There's a multitude of other handy shortcuts in Windows 10, including pressing **Win** and **=** together, which opens the magnifier tool to help you zoom in on hard-to-read text. Elsewhere, pressing **F2** when a file is highlighted enables you to rename it.

›› Most people know that pressing **Print Screen** copies an image of your current screen to the clipboard, but that requires you to then open an image-editing program, paste the image, and save it. Instead, press **Win-Print Screen** and Windows automatically saves an image of your screen to your "Pictures → Screenshots" folder. Alternatively, press **Alt-Print Screen** to copy an image of only the currently active window to the clipboard, or you can press **Win-Shift-S** to capture only a portion of the screen.

›› And we've saved the best for last. When Windows inevitably bugs out on you, press **Win-F** to automatically take a screenshot, open the Feedback Hub, and then attach the screenshot to it. You know even Microsoft recognizes the frequency of Windows bugs when it creates a specific shortcut for reporting them.

WINDOWS EXPLORER SHORTCUTS

Windows Explorer is more than just a simple app—it has a veritable gold mine of shortcuts that enable you to get much more from it.

For instance, pressing **Num Lock** and ***** expands every folder below the one you've currently selected; **Num Lock-Minus (-)** collapses them all again. **Num Lock-Plus (+)** expands the currently selected folder without expanding its subfolders. Note that this only works with the plus and minus keys on the number pad.

When you've selected a file, press **Alt-P** to open the preview pane. **Alt-Enter** opens the Properties window for the file. Pressing **Alt** and either up, left, or right enables you to navigate through folders, and holding **Ctrl** while scrolling the mouse wheel up or down changes the size and appearance of the folder icons.

Press **Alt-D** to highlight the address bar; you can then copy the highlighted location into the "Save" dialog box in your web browser to save a file there, for example. Finally, you can press **Ctrl-Shift-N** to create a new folder in the current location.

Recover or Repair Windows 10

YOU'LL NEED THIS

WINDOWS 10
You might also need to resort to using your Win 10 installation disc.

IF YOU'RE LUCKY, you will have a trouble-free experience with Windows 10, but—realistically—it's quite likely that something will go wrong at some point. You may be experiencing a lot of crashes or error messages, or you might even find that Windows won't boot at all. If you can't even start your computer, how are you supposed to fix things?

Thankfully, there's a number of recovery methods built into Windows 10 that should help you get back up and running with the minimum of fuss.

While it's natural to panic a little when Windows goes awry, the various recovery tools and options that exist should mean that you can fix the problem without putting your valuable data at risk. Even if you have to reinstall Windows because of a more serious problem, it should still be possible to safeguard your files. –MARK WYCIŚLIK-WILSON

1 ADVANCED STARTUP OPTIONS

The first step to fixing Windows is to access the Advanced Startup Options. In Windows, you can open "Settings," go to the "Update & Security" section, and click "Recovery" followed by the "Restart now" button under "Advanced startup." If Windows is not starting up, you can press F11 during the boot process. Select "Troubleshoot" [**Image A**] followed by "Advanced options" from the blue menu.

2 STARTUP REPAIR

You are presented with six options, the first of which is "Startup Repair." Use the arrow keys to select this, then press Enter. When your computer restarts, select your user account from the menu, enter your password, and click "Continue." Windows then tries to find and fix any startup problems. If no problems are found, click "Advanced options" to return to the main menu.

3 STARTUP SETTINGS

Even if "Startup Repair" doesn't find any problems, you can still use "Startup Settings" to enter Safe mode. After selecting the option, click the "Restart" button, and you'll see another menu. If your graphics card might be the problem, press 3 to enter a low-resolution mode that enables you to tweak settings. Options 4 and 5 boot you into Safe mode either without or with network access.

4 USE SAFE MODE

Safe mode only loads the essential components of Windows 10. You should be able to start your PC in it, because anything that could cause a problem should be bypassed. Things might look a little ugly, because only basic graphics are used, but it gives you the opportunity to head to "Settings" and uninstall any problematic software, or "Device Manager" [**Image B**] to roll back to an older version of a driver.

5 UNINSTALL UPDATES

Updates for Windows are supposed to either fix problems or introduce new features—but things can go wrong. If you've installed an update only to find it causes issues, select "Uninstall Updates" from the "Advanced Options" menu. You can choose to uninstall the most recent "quality update," or expunge the latest "feature update" (the big updates that come once or twice a year) [**Image C**].

6 SYSTEM RESTORE FROM WITHIN WINDOWS

System Restore automatically backs up the registry and key system files in case anything goes wrong. You can also do it manually. Find System Restore by clicking the "Start" button and searching for it. If there are restore points available, select the one you'd like to use, and click "Next" [**Image D**]. Click "Finish" and the restoration process continues.

7 SYSTEM RESTORE WHEN WINDOWS WON'T BOOT

If you can't boot into Windows, you can access System Restore from the "Advanced Options" boot menu. Having selected "System Restore," select your user account when your PC restarts, enter your password, and click "Continue." You can then use System Restore [**Image E**] as described in the previous step.

8 RESET WINDOWS 10

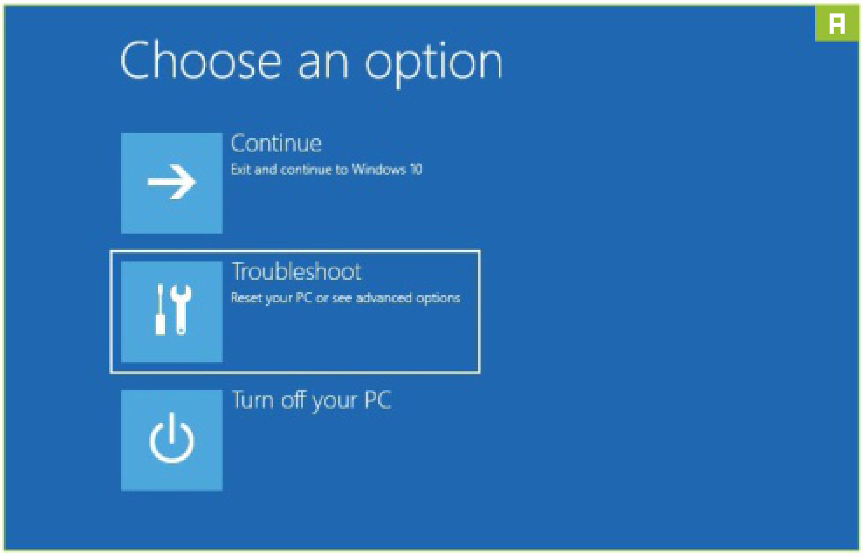
Another way you can effectively rid your PC of problems is by performing a reset. If you have loaded the "Advanced Options" menu, click the back button, then choose "Reset this PC" [**Image F**]. This reinstalls Windows 10 for you, but first you are given the choice of keeping your personal files, or wiping them. Click one of these options followed by "Reset," then sit back and wait.

9 SYSTEM IMAGE RECOVERY

The final option on the "Advanced Options" menu is "System Image Recovery" [**Image G**]. This enables you to restore Windows 10 from a backup. This could be one you have created yourself, or it could be an image that was included with your PC by the manufacturer. You simply need to select the image you want to work with, and you're guided through the rest of the process.

10 REINSTALL WINDOWS 10

Sometimes you may have no choice but to reinstall Windows from scratch. If you have a Windows 10 installation disc, you can boot your PC from it and run through the reinstallation, otherwise you have to use the Microsoft Media Creation tool (www.microsoft.com/software-download/windows10) on another PC to download Windows 10 and burn it to a DVD [**Image H**]. ⏻



Choose an option

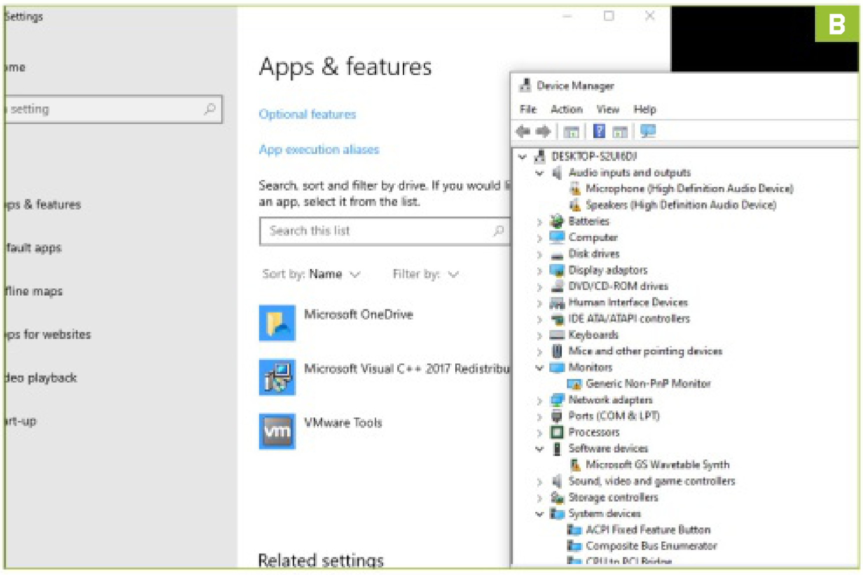
Continue

Exit and continue to Windows 10

Troubleshoot

Reset your PC or see advanced options

Turn off your PC


B
Settings
me
setting
ps & features
fault apps
fline maps
ps for websites
deo playback
rt-up

Apps & features

Optional features
App execution aliases

Search, sort and filter by drive. If you would
an app, select it from the list.

Search this list
Sort by: Name
Filter by:

Microsoft OneDrive

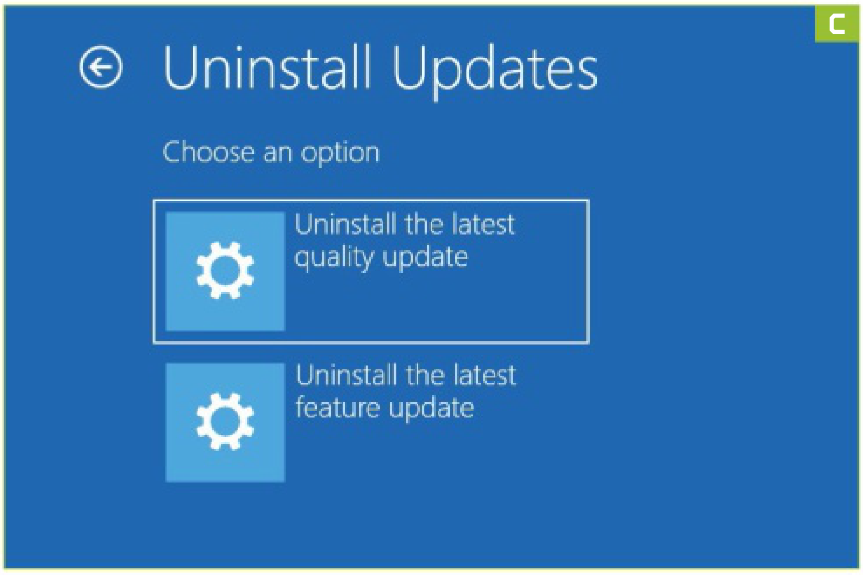
Microsoft Visual C++ 2017 Redistribu

VMware Tools

Related settings

Device Manager
File
Action
View
Help

DESKTOP-S2UI6DJ
- Audio inputs and outputs
  - Microphone (High Definition Audio Device)
  - Speakers (High Definition Audio Device)
- Batteries
- Computer
- Disk drives
- Display adaptors
- DVD/CD-ROM drives
- Human Interface Devices
- IDE ATA/ATAPI controllers
- Keyboards
- Mice and other pointing devices
- Monitors
  - Generic Non-PnP Monitor
- Network adapters
- Ports (COM & LPT)
- Processors
- Software devices
  - Microsoft GS Wavetable Synth
- Sound, video and game controllers
- Storage controllers
- System devices
  - ACPI Fixed Feature Button
  - Composite Bus Enumerator

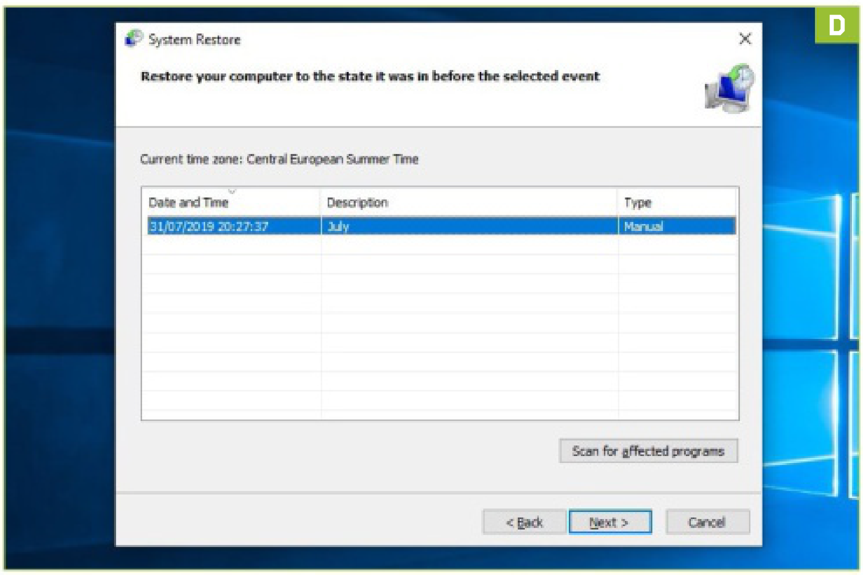


Uninstall Updates

Choose an option

Uninstall the latest quality update

Uninstall the latest feature update

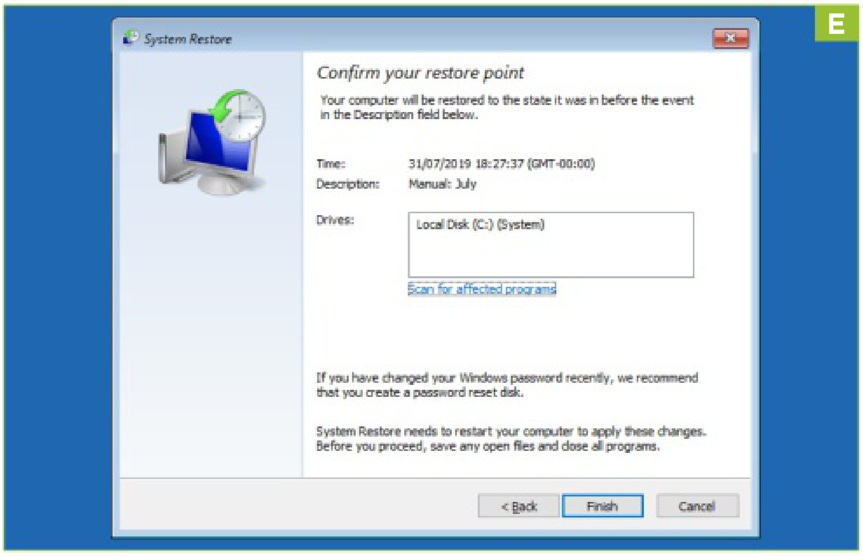

D
System Restore

Restore your computer to the state it was in before the selected event

Current time zone: Central European Summer Time

Date and Time	Description	Type
31/07/2019 20:27:37	July	Manual

Scan for affected programs
< Back
Next >
Cancel


E
System Restore

Confirm your restore point

Your computer will be restored to the state it was in before the event in the Description field below.

Time: 31/07/2019 18:27:37 (GMT-00:00)

Description: Manual: July

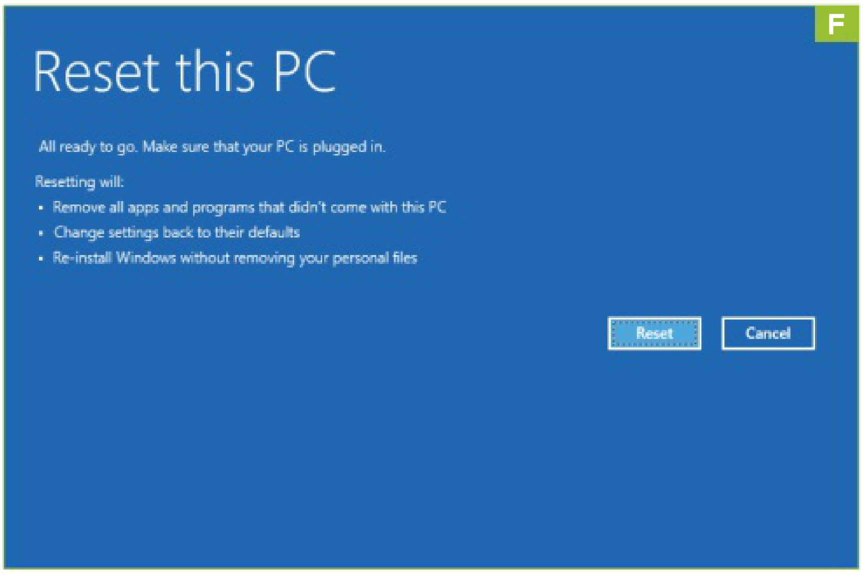
Drives: Local Disk (C:) (System)

Scan for affected programs

If you have changed your Windows password recently, we recommend that you create a password reset disk.

System Restore needs to restart your computer to apply these changes. Before you proceed, save any open files and close all programs.

< Back
Finish
Cancel

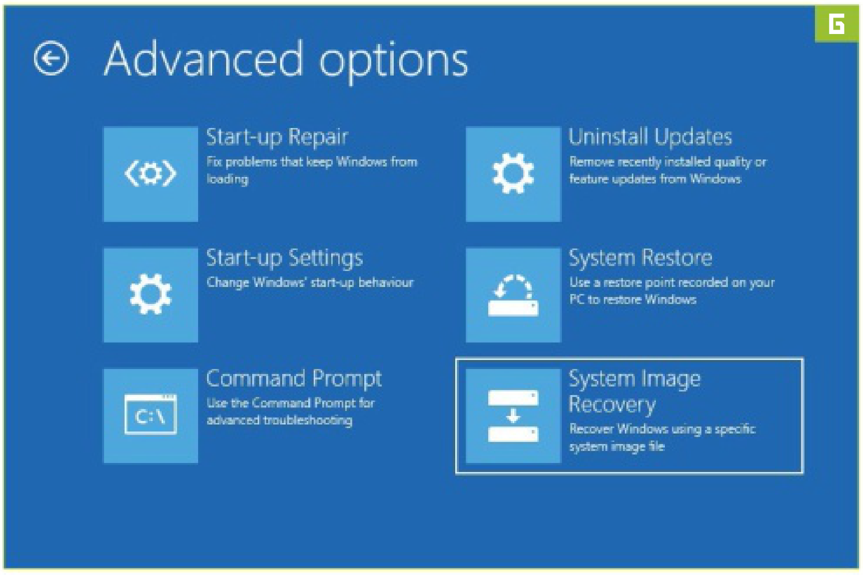

F

Reset this PC

All ready to go. Make sure that your PC is plugged in.

Resetting will:
- Remove all apps and programs that didn't come with this PC
- Change settings back to their defaults
- Re-install Windows without removing your personal files

Reset
Cancel



Advanced options

Start-up Repair

Fix problems that keep Windows from loading

Uninstall Updates

Remove recently installed quality or feature updates from Windows

Start-up Settings

Change Windows' start-up behaviour

System Restore

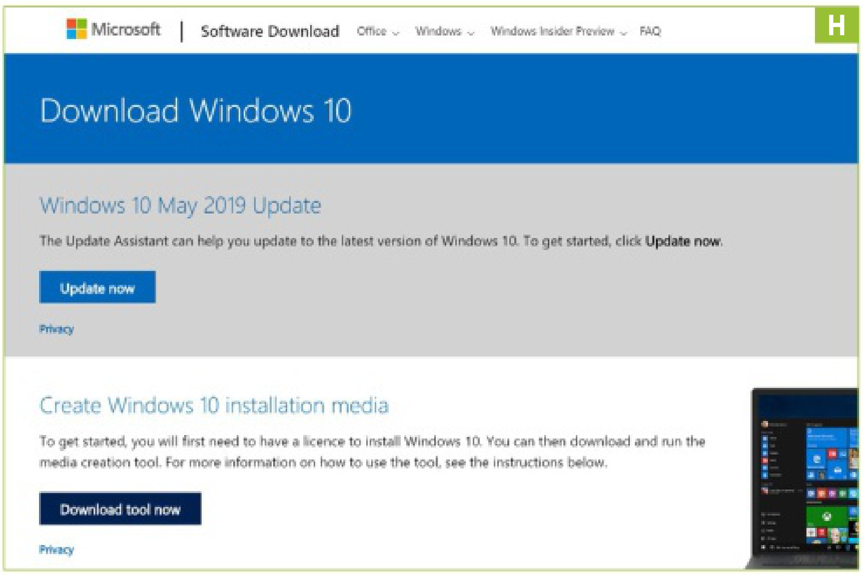
Use a restore point recorded on your PC to restore Windows

Command Prompt

Use the Command Prompt for advanced troubleshooting

System Image Recovery

Recover Windows using a specific system image file


H
Microsoft
Software Download
Office
Windows
Windows Insider Preview
FAQ

Download Windows 10

Windows 10 May 2019 Update

The Update Assistant can help you update to the latest version of Windows 10. To get started, click **Update now**.

Update now
Privacy

Create Windows 10 installation media

To get started, you will first need to have a licence to install Windows 10. You can then download and run the media creation tool. For more information on how to use the tool, see the instructions below.

Download tool now
Privacy

© MICROSOFT WINDOWS 10

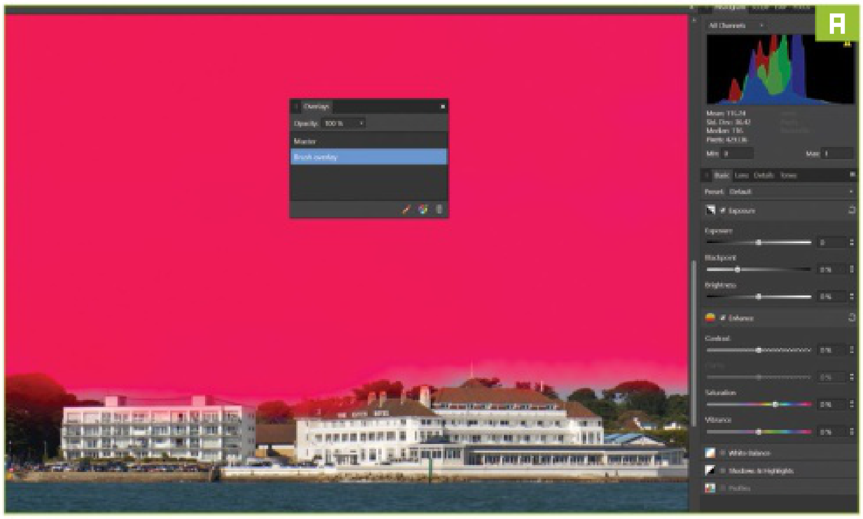
Explore Affinity Photo's Personas

YOU'LL NEED THIS

AFFINITY PHOTO
Grab a free trial from http://bit.ly/AfPhotoTrial.

SERIF'S AFFINITY SUITE of creativity apps, recently completed with the release of Publisher, has a quirk not found elsewhere. Each app is divided into sections, known as Personas, which are tailored toward a specific task, and which change the layout of the controls when you enter them. Affinity Photo, for example, has the Photo Persona, for carrying out most image editing; the Liquify Persona, for pixel-bending effects; the Develop Persona, for processing raw image files; the Tone Mapping Persona, for creating HDR images; and the Export Persona, for busting down file sizes and fine-tuning compression ratios. Vector graphics app Designer has something similar, while Publisher acts as a keystone, tying the others together, integrating them into its Personas, so you don't need to leave one app to use another.

That's a lot for one app, but they're functions that, in other programs, would be filters or complex dialog boxes. It's an intelligent use of the space afforded to the interface to split them up, enabling you to focus on the task at hand, and perhaps even saving time, because you can organize them into a seamless workflow. Here's how they work. – **IAN EVENDEN**



1 RAW FILES

Developing raw files in Affinity is like using Lightroom. Go to "File → Open" and choose your file. If a raw image is detected, Affinity opens it in the Develop Persona. The tools are similar to those in Lightroom or Adobe Camera Raw, but if you ever wonder how something works, there's a handy tip at the bottom-left.

2 DEVELOP TABS

Apart from cropping, you can largely ignore the tools on the left. The real action is on the right, where you'll find sliders—as in Lightroom. But there's a neat difference between Serif's and Adobe's products—adjustments are organized into groups that can be switched between via tabs, which can also become free-floating windows. The "Basics" and "Enhance" sections contain tools such as "Exposure," "Shadows," and "Highlights." There's a lens corrections tab, with profiles for one-click correction of popular lenses, plus check boxes for the removal of chromatic aberration, colored fringing, and vignetting. Sharpening (or "Detail Refinement") and noise reduction live in the "Details" tab, while controls for monochrome conversion and split-toning live under "Tones," along with the curves graph.

3 OVERLAYS

You can paint an adjustment on to your raw image using the "Overlays" tab, and the three Overlay tools on the left: paint, erase, and gradient. Creating a new Overlay enables you to select an area you want to adjust separately from the rest of the image using the Overlay Brush or Gradient, using the eraser to tidy it up, selecting it in the "Overlay" tab, and making an adjustment in another tab. Blend it in with the rest of the image using an opacity slider. To edit the entire image, switch back to "Master" [**Image A**].

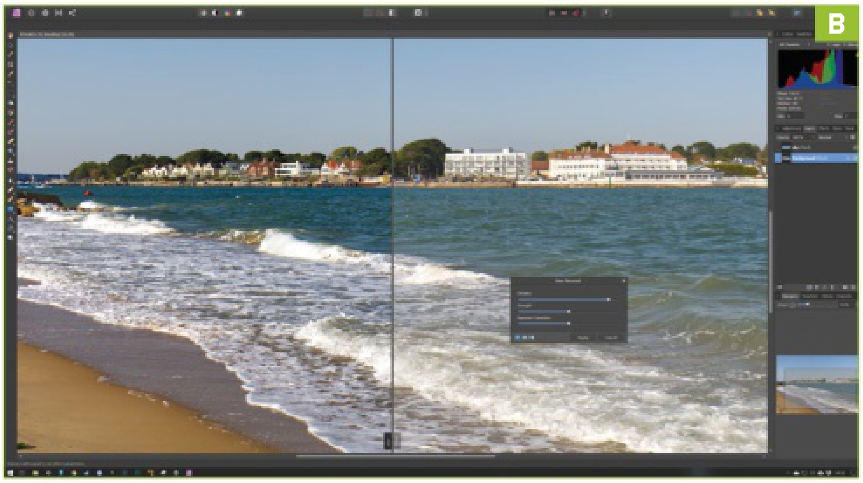
4 PHOTO PERSONA

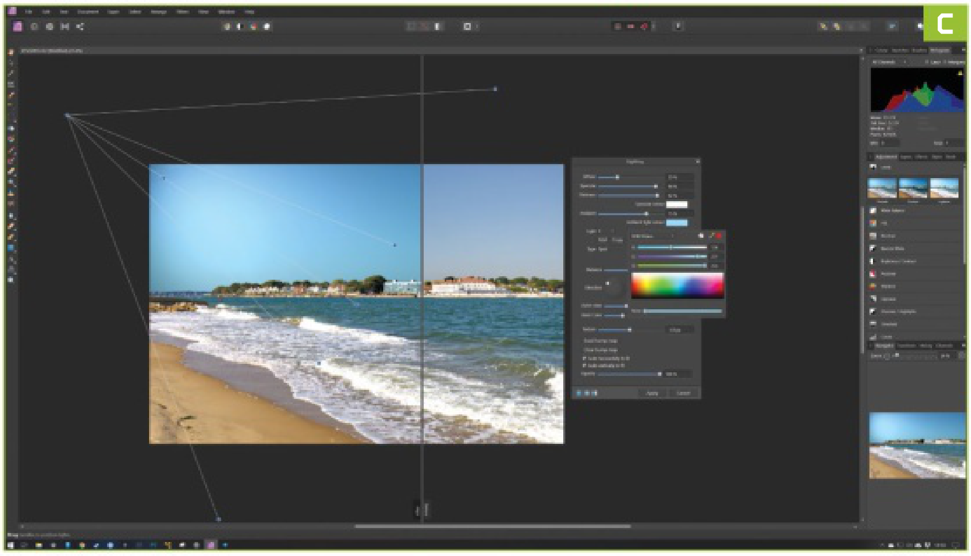
To finish developing a raw file, press "Develop." After some processing, you're taken to the Photo Persona, Affinity's main image-editing interface. This is a layered image-editing app akin to Photoshop, but most of the simple tweaks, such as levels or color saturation, could have been taken care of at the Develop stage. In Photo, these are added as Adjustment Layers, or there are auto versions hiding in the "Filter" menu. The "Adjustment" palette on the right houses edits such as "Brightness/Contrast" or "Hue and Saturation."

›› You can also add text to your photo, splice in sections from other images, or run filters on it. We chose to run the "Haze Removal" filter on our seascape, opening up Affinity's split view to see the difference the filter was making with a before and after view [**Image B**].

5 LIGHTING

We can also play with the impressive "Lighting" filter to change the way the hazy fall sun dapples





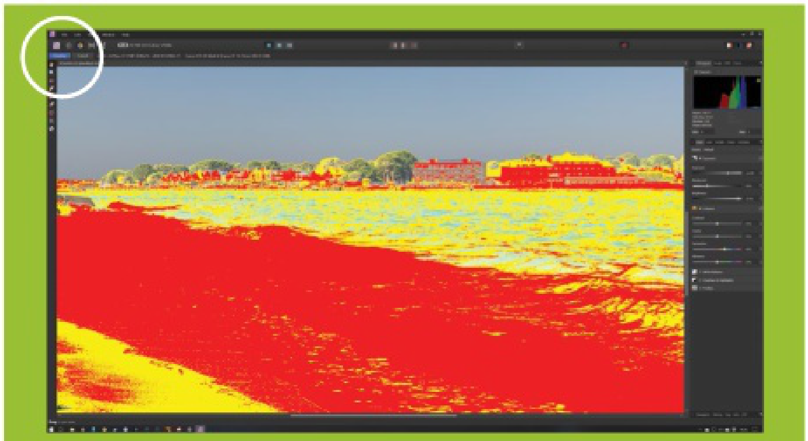
across the bay. Find it in the "Filter" menu, and prepare for a surprise, as it looks nothing like the filters we're used to. It places a new light source, enabling you to choose the parameters that make it up. We've only got the sky selected here, so brightening one corner and making the light bright blue gives the impression of a sunlit summer sky, rather than the overcast, windy, verging-on-cold conditions we shot the photo in. Again, the before and after split view is useful if you want to see exactly what you've changed. The vertical terminator can be slid left and right to cover and uncover the image as you want [**Image C**].

6 EXPORT

Once you've finished in the Photo Persona, save your file as a layered .afphoto file, to preserve it in a state you can return to later for further editing. To create a small but highly detailed file for sharing online, you can switch to the Export Persona, which has a host of options. Export is based on slices—you can carve an enormous composite image up and export parts of it as individual files. It also preserves the layer structure prior to export, so you can export individual layers as files [**Image D**].

›› There's a "Slice" tool on the left you can use to select areas of your image to export as files, if that's what you want. To export layers, select one in the "Layers" panel, and choose "Create Slice." There's an "Export Options" panel at the top-right in which you can set the file type, bit depth, and compression level of the files you're creating. When you've finished, open the "Slices" panel and either click "Export Slices (N)," where N is the number of slices to export all selected slices, or do it one at a time.

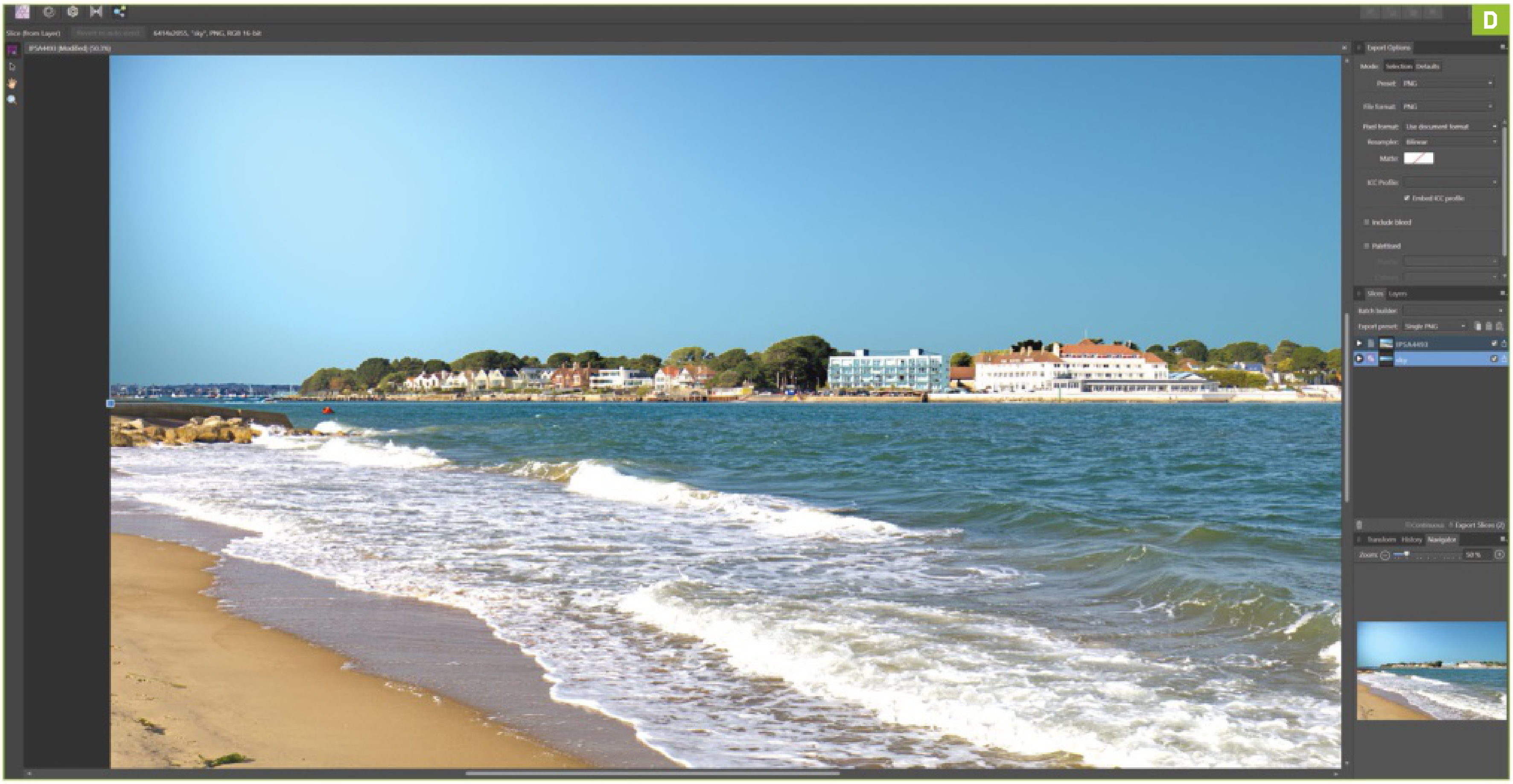
›› You can export a single file from the Photo Persona using "File → Export." You get a choice of file types, resampling methods, and compression ratios, but the whole Slices thing is no longer a complication. ⏻



LAYERED DEVELOPMENTS

The Develop Persona can be used on an individual layer if you find it a good way to edit. While we recommend shooting raw images in your camera and treating Affinity (or Lightroom/Adobe Camera Raw) as a digital darkroom, Develop can do a lot with processed data.

Split your image into layers, using something like the "Flood Select" tool to perhaps carve the sky from the landscape, then make sure that, while both are visible, only one is selected in the "Layers" palette on the right of the Photo Persona. Click the button at the top-left that takes you to Develop, and Affinity remembers where the dividing line is. Any adjustments you make in Develop only apply to the layer you had selected.



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TESTED. REVIEWED. VERDICTIZED.

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ACER CONCEPTD 500 PAGE 76

Acer ConceptD 500

Acer enters the fray with new designer hardware

ACER RECENTLY came by to deliver us a presentation about its new line of products, the ConceptD range. Apparently, the D stands for "Design" not.... Well, who knew? Real talk, though, Acer has zeroed in on a key problem with the computer hardware market: Content creators are experiencing a dearth of purpose-built systems, instead opting to buy powerful gaming PCs for their 4K video-editing needs. That wouldn't necessarily be a problem, if it weren't for the fact that many working professionals don't want a giant, glowing RGB unit shooting red and blue lighting all over the place.

So, the ConceptD 500. The standard desktop model in the ConceptD range (which includes laptops, monitors, and more) is a high-powered system, meant to integrate seamlessly and unobtrusively into office spaces with a simple, aesthetically pleasing design. Convenience is a cornerstone of this system's design; the faux-wood finish on top includes a Qi wireless charging pad hidden beneath, enabling you to drop your phone atop the case for a battery boost. At the front, a quick press reveals a spring-loaded mount to hang a pair of headphones on. The top I/O is covered with an odd plastic shield that can be removed to access it; we get the impression that it would be tossed aside immediately by 95 percent of users, but that's fine.

As Acer describes it, the ConceptD 500 is "elegantly honest." There are no hidden bells and whistles here, just high-quality components inside a minimalist case. When powered on, the gray plastic ring surrounding the wooden top panel emits a (slightly feeble) orange glow. At the rear, two silver clips at the top and bottom of the panel allow for some cable management. It's also impressively quiet; the front panel appears solid at first glance, but subtle gaps in the triangular design allow for air to be drawn in by the case fans, although said fans are pretty tiny. Even running under stress, the volume stays respectably low.

Of course, it's all about the hardware inside. A Core i9-9900K processor powers this system, backed up by a mighty 64GB of DDR4-2666 memory, prepped and ready for complex design work. Graphics are handled by a $1,000 RTX Quadro 4000 GPU, ideal for everything from 3D architectural rendering to driving high-fidelity environments in VR, and as the name implies, we've got full ray-tracing support, too. The OS boots from a high-speed M.2 drive, which also ensures that any programs load rapidly. Two more HDDs provide an additional 4TB of storage for videos, images, and more, with models packing both 2.5-inch and 3.5-inch drives.

The system also comes with a handful of slightly unusual but still beneficial features. Pre-loaded on to the desktop is ConceptD Palette, a simple system-monitoring tool that lets you check the usage of your CPU, GPU, and memory at a glance. There's also a system health indicator LED on the top I/O, which pings should something untoward occur. Lastly, there's an intrusion alarm. This triggers a notification on boot next time the system powers up, should the case be opened—a tamper alert, essentially.

The ConceptD 500 is something of a new breed. Built specifically with workstation functions in mind, it doesn't really fit our usual selection of game benchmarks. For comparison here, we've used our regular 4K build, but going forward, you'll see this system acting as our zero-point for workstation PCs. To that end, we tested a few pieces of software: Fry Render and SPECviewperf 13 both returned favorable results. The table below might make it look like this desktop struggles in comparison to older systems, but that's not the case in practice.

While this is a competent platform for 4K gaming, that's not what it was designed for; instead, it excels at rendering, video editing, and 3D art. Versatile, it's at home in the office space of a graphic design business or the home office of an architect. Cracking open the case doesn't show anything appealing, just a mess of cables and unbranded silicon, but the target audience isn't likely to want to make modifications. If you're looking for a workstation PC to support your tech startup or 3D animation firm, this is the machine for you. –**CHRISTIAN GUYTON**

VERDICT

9

Acer ConceptD 500

DESIGNER Powerful hardware; charming visual design; purpose-built for creatives.

DISASTER A little pricey; tricky to modify; weak case fans.

$4,000, www.acer.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	2,178	1,778 (-18%)
CrystalDisk QD32 Sequential Read (MB/s)	3,136	3,460 (10%)
CrystalDisk QD32 Sequential Write (MB/s)	2,126	2,784 (31%)
3DMark: Fire Strike (Index)	6,988	4,888 (-30%)
Rise of the Tomb Raider (fps)	68	45 (-34%)
Total War: Warhammer II (fps)	42	32 (-24%)
Tom Clancy's Ghost Recon: Wildlands (fps)	38	27 (-29%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i9-7900X, 32GB G.Skill RipJaws V series DDR4 @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512GB Samsung 960 Pro PCIe SSD. All tests performed at 4K at the highest graphical profile.

SPECIFICATIONS

CPU	Intel Core i9-9900K
Graphics	Nvidia RTX Quadro 4000
RAM	64GB (4x 16GB) Kingston DDR4-2666
Motherboard	Unbranded X299
Primary Storage	Western Digital SN720 1TB M.2 NVMe SSD
Additional Storage	2x Toshiba 2TB 3.5-inch HDDs
Cooling Solution	Air cooler
PSU	LiteOn 500W 80+ Gold
Case	ConceptD 500
Warranty	One year

The top I/O has support for both USB-C and USB-A connectors.

Acer Predator Helios 700

The monster machine

NO, NOBODY THREW their back out trying to lift this thing. Yet. Acer's newest high-powered gaming laptop is, as the Internet would say, an "absolute unit." We truly are in awe of its size. More than an inch and a half thick and weighing 10 pounds, this isn't a system for the casual gamer on the go. It is, fundamentally, a desktop replacement; at three and a half grand, it costs comfortably more than plenty of prebuilt and custom desktop systems, and is ready to match them in performance, too.

The hardware inside this machine is, frankly, staggering. In addition to an eight-core, ninth-generation Core i9-9980HK processor, and up to 64GB of RAM at 2,666MHz, this beast has a full-sized Nvidia GeForce RTX 2080 inside; not a slimmer, slower Max-Q model, like you'd find in most laptops, but a mighty desktop GPU. There's also one terabyte of storage, in high-speed M.2 NVMe Gen 3.0 trim, no less. The system has some monstrous overclocking potential, too, utilizing Acer's own PredatorSense software for easy, on-the-fly system tweaking and monitoring that can even be controlled via an app for mobile devices.

Of course, all that power produces a significant amount of heat. Acer has been firing on all cylinders when it comes to cooling solutions for this machine, and it shows; there are vents on three of the four edges, and the two powerful fans are surrounded by a whopping five copper heat pipes that dissipate the excess heat from the processor and graphics card. All that pales in comparison to the ultimate in dynamic cooling, something Acer calls the HyperDrift keyboard, which slides down the chassis to reveal a vapor chamber, channeling cool air through the machine at an incredible rate.

When in use, the keyboard situates itself at the base of the chassis, while the trackpad and the bezel around it fold down to form an angled wrist rest. This mode truly does away with the "laptop" moniker the system is clinging desperately on to; with the vapor chamber open, this isn't fitting on anybody's lap. The more powerful overclocking presets demand that the keyboard be extended and the system be connected to an external power source (and the charger is not what we'd describe as "lightweight" either), and the fans can get very loud when running at load; we're talking jet engine more than desk fan, here.

FAN FRICTION

These are relatively minor complaints, though. With auto overclocking engaged, the fans rarely hit frustrating volumes, and are virtually unnoticeable while wearing headphones (a courtesy not extended to those around you, of course). And, yes, while it's not the most portable machine we've reviewed, it's still easier to move around than a desktop PC. If you're a gamer who has to travel a lot for work, or if desk space at home is limited, this could be an ideal replacement.

When it comes to the external hardware, the Helios 700 doesn't let up. While the screen is only a standard 17.3-inch 1080p display, it has a refresh rate of 144Hz and is Nvidia G-Sync compatible, which serves to reduce blur and improve frame rates in games. The keyboard feels good to use, with "Magforce" WASD and arrow keys that can detect variable input pressure to produce an analog-stick-esque effect. There are also three mappable hotkeys, which can be swapped between three color-coded function groups. The trackpad is illuminated in cool blue around the edges, and the RGB lighting of each key can be individually adjusted in PredatorSense. Our only gripe here would be that the trackpad buttons feel a little spongy, but anyone who owns this laptop should really be using a mouse anyway.

Lastly, there's the audio. It's pretty good—not mind-blowing, but as effective as one might expect from a machine this price—utilizing five speakers and one subwoofer for effective surround sound. The Helios 700 also uses Waves NX 3D Sound to improve headphone performance, although that's still going to be mostly dependent on your headset. On the whole, though, if you're looking for a seriously beefy laptop, this is the way to go. **–CHRISTIAN GUYTON**

VERDICT

9

Acer Predator Helios 700

+ POWERHOUSE Incredible performance; 144Hz display; customization in PredatorSense.

– OVERWEIGHT Fans are extremely noisy; bulky and heavy.

$3,499, www.acer.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,030	1,801 (75%)
CrystalDisk QD32 Sequential Read (MB/s)	3,374	3,490 (3%)
CrystalDisk QD32 Sequential Write (MB/s)	2,530	3,221 (27%)
3DMark: Fire Strike (Index)	13,610	22,674 (67%)
Rise of the Tomb Raider (fps)	92	149 (62%)
Total War: Warhammer II (fps)	62	103 (66%)
Tom Clancy's Ghost Recon: Wildlands (fps)	49	76 (55%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Best scores are in bold. Our gaming laptop zero-point is the Acer Predator Triton 500, with an Intel Core i7-8750H, Nvidia GeForce RTX 2060 Max-Q, and 16GB of DDR4-2666. All game tests are performed at 1080p at the highest graphical profile.

SPECIFICATIONS

CPU	Intel Core i9-9980HK
Graphics	Nvidia GeForce RTX 2080
RAM	64GB DDR4-2666 SDRAM
Screen	17.3-inch 1080p @ 144Hz
Storage	1TB PCIe NVMe M.2 SSD
Ports	HDMI, DisplayPort, 3x USB 3.1 Gen 2 Type-A, 2x USB 3.1 Gen 2 Type-C, RJ-45, audio
Connectivity	Gigabit Ethernet, 802.11ac, Bluetooth 5.0
Weight	10lb
Size	16.9 x 11.8 x 1.6 inches

Sliding out the keyboard results in a very satisfying clunk.

acer
Color Accuracy

Acer's 32-inch 4K monitor is aimed squarely at professionals.

Acer ProDesigner BM320

Suck it up gamers, this screen isn't for you

THE ACER PRODESIGNER BM320 ain't exactly cutting edge. There's a reason for that though—it was originally released at the end of 2017. So, there's no HDR and it's limited to a 60Hz refresh rate. But that isn't necessarily all bad. For starters, the price is only going in one direction.

More on that later; first, let's size this generously proportioned monitor up. The key metrics are the 32 inches of screen diagonal and full UHD or 4K resolution, the latter translating into a fulsome 3840x2160 pixels. Moreover, as the "mere" 60Hz refresh implies, it's not aimed at gamers, which is actually a relief, such is the preponderance of both gaming screens and gaming-focused technology in the monitor market of late.

Instead, the Acer ProDesigner BM320 has pros in general and content creators in particular as its target demographic. With that in mind, you get features such as 10-bit color per channel (though Acer doesn't make it clear if the panel natively supports that) and multiple color space presets, including AdobeRGB, sRGB, and Rec.709. Acer says the BM320 covers 100 percent of the AdobeRGB space.

So, the Acer ProDesigner BM320 is an old schooler in an age of HDR and high-refresh upstarts. There's no adaptive sync, no local dimming, just a large, high-quality, high-res panel. Incidentally, that panel is of the IPS rather than TN or VA persuasion, the better for color accuracy.

Initial impressions are impressive. The BM320's colors are seriously punchy and, subjectively, the contrast looks strong. In fact, such is the vibrancy and saturation, the overall impression is more VA than IPS. However, closer inspection reveals the screen's true IPS-derived character.

That includes very wide viewing angles and impressive detail in color scales and test images. Those color space presets also ensure that the BM320 is ready for most—but not quite all—workflows. The obvious exception involves HDR content. In terms of content consumption, we couldn't care less about the lack of HDR support. For that remit, this screen looks every bit as good as those with entry-level HDR support. In other words, screens without local dimming, which is most HDR-compliant PC monitors today.

However, the lack of HDR support could be a deal-breaker for content creation. Other upsides include a smooth anti-glare coating, slim bezels on three sides, and plenty of connectivity, including DisplayPort, HDMI, and even DVI.

That 4K resolution on a 32-inch panel makes for a pleasingly tight pixel pitch and crisp fonts, not to mention lots of desktop real estate. At 32 inches, many users will be comfortable running the BM320 at 100 percent scaling, maximizing on-screen elbow room. Rounding the plus points out are excellent build quality and a robust-feeling stand that offers a comprehensive range of adjustment, including the ability to rotate into portrait mode.

As for niggles, the aforementioned HDR-related limitations aside, the most obvious flaw is noticeable input lag. Were this a gaming panel, it would be a very serious problem. For content creation, it's more of an annoyance. Suffice to say, if you're looking for an upscale all-arounder with a bit of gaming included, this Acer isn't the best option.

All of which leaves the sordid matter of money. Right now, the Acer ProDesigner BM320 is just over $800. However, we noticed its price had fallen to as little as £400 over in the UK, which works out at around $500. We suspect the US price is heading in the same direction, given the maturity of this model. And at that kind of money, it's one hell of a package, even with the limitations. **–JEREMY LAIRD**

VERDICT
7

Acer ProDesigner BM320

+ VALUE PROPOSITION Gorgeous 4K IPS panel; multiple color spaces supported.

− FALSE ECONOMY No HDR support; some noticeable input lag; not exactly cheap.

$810, www.acer.com

SPECIFICATIONS

Panel Size	32-inch
Panel Type	IPS
Resolution	3840x2160
Pixel Pitch	138 ppi
Brightness	$350cd/m^2$
Contrast	100m:1 (dynamic)
Response	5ms
VESA Mount	100 x 100mm
Warranty	Two years

The Flip 13 is good for a spot of casual gaming, too.

Asus Zenbook Flip 13

Three hundred and sixty degrees of cool

THERE'S SOMETHING rather enticing about the Zenbook Flip 13, but we can't quite put our finger on it. Convertible laptops can be hit and miss, but the latest in Asus's Zenbook line feels as though it might have struck gold. Lightweight but not flimsy, silent but not underpowered, this is the ideal on-the-go tablet or at-home work laptop. We'd love one of these for the long treks to distant press conferences and media events, but at just under $1,000, it's not exactly the most affordable notebook in the business.

You get a lot for your money, though. Despite weighing less than a bag of apples, it packs plenty of hardware. Our model comes with an Intel Core i5-8265U—a more powerful i7 version is also available—along with 8GB of RAM, a 256GB PCIe SSD, and integrated Intel UHD Graphics 620. It's whisper-silent, thanks to passive cooling, and has a smaller footprint compared to its predecessor, with a tiny bezel around the screen.

It's a lovely unit, and one we're not afraid of snapping like so much spaghetti when we flip it into tablet mode with our giant hands. Yes, some of our reviewers are comparable in stature to the Sasquatch. The 360-degree hinge is supposedly rated for 20,000 cycles, according to Asus's "hinge testers." Yes, apparently that's a real job. The hinge testers have clearly been working hard, though, because the hinges do indeed feel nigh-unbreakable. The metallic blue finish looks great, and on inspection, is quite resistant to light damage.

The same can't be said of the touchscreen, which, like many two-in-one notebooks, was frustratingly covered in fingerprints after just a brief period of use. Be prepared to either shell out for a compatible stylus or carry a microfiber cloth around. Yes, this half-tablet doesn't come with a stylus or smart pen, which feels slightly like a missed opportunity, but is by no means a deal-breaker for most users. For on-the-go artistic types, though, it could be a drawback. Asus does sell its own smart pen, which by all accounts is a good tool for digital art, but it weighs in at an extra $80.

The 1080p display looks brilliant, providing vibrant color and glare reduction, which comes in handy when working in a brightly-lit or outdoor environment. The 90 percent screen-to-body ratio is a great improvement on older Zenbooks, and the screen is viewable from wide angles without color or image distortion—perfect for watching movies in the tent orientation. This does raise some privacy concerns, however; with such a wide viewing angle, it's all too easy for prying eyes to espy your work in a public space.

Staying with the notion of privacy, the Flip 13 has two cameras: one in the usual above-screen orientation for standard webcam purposes, and a second one to the left of the keyboard, facing directly up. It's an odd design choice, but it effectively works as an external rear camera when the notebook is in tablet mode. The downside is that neither camera has a cover or dedicated kill switch, features that have become increasingly popular in modern notebooks.

With regard to the external hardware, the keyboard feels comfortable and responsive, with white backlighting and a satisfying amount of key travel. The trackpad functions well and conceals a nifty new feature: With the click of a button, a hidden numpad illuminates beneath the trackpad. Not everyone will use it, but it's handy for anyone who works with numbers (and is a nice little feature to show off on your cool new notebook).

There's not much else to say; this is a solid convertible notebook that performs reasonably well. The brilliant audio—courtesy of sound master Harman Kardon—only serves to sweeten the deal. One disappointment lies in the lack of an M.2 SSD, but many users won't notice much of a difference; the relatively small 256GB storage capacity means that shuffling massive files around isn't really a possibility anyway. This notebook isn't without its drawbacks, but for a busy professional on the move, it gets the job done well. **–CHRISTIAN GUYTON**

VERDICT

8

Asus Zenbook Flip 13

+ FLIP Resilient design; bright screen; high-quality audio.

− FLOP Little in the way of privacy features; SATA-speed SSD.

$900, www.asus.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	561	671 (20%)
CrystalDisk QD32 Sequential Read (MB/s)	3,100	559 (-82%)
CrystalDisk QD32 Sequential Write (MB/s)	557	500 (-10%)
3DMark: Fire Strike (Index)	1,062	1,176 (11%)
Rise of the Tomb Raider (fps)	5	5 (0%)
Total War: Warhammer II (fps)	2,543	3,385 (33%)
Tom Clancy's Ghost Recon: Wildlands (fps)	840	480 (-43%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our notebook zero-point is the HP Spectre X360, with an Intel Core i7-8565U, integrated Intel UHD Graphics 620, and 8GB of DDR4-2400. All games tested at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i5-8265U
Graphics	Integrated Intel UHD Graphics 620
RAM	8GB LPDDR3-2133
Screen	13.3-inch 1080p 100 percent sRGB color gamut
Storage	256GB SATA3 SSD
Keyboard	Full-size island-style backlit
Battery	Three-cell 50Wh
PSU	65W AC adapter
Weight	2.9lb
OS	Windows 10 Home 64-bit

CROSSHAIR VIII
START
RESET
OPTIMEM III
SOCKET AM4
REPUBLIC OF GAMERS
SUPREMEFX

Unlimited powerrrrrrrrrrrr!!!

Asus ROG Crosshair VIII Formula

Pure power and a monstrous I/O

WHEN AMD LAUNCHED its third-gen Ryzen processors, they represented a massive change. Keen to cement the success of its first and second-gen chips, and taking advantage of its Zen 2 architecture, AMD pushed both core count and single-core IPC in its new processors to the max. But in a frantic attempt to stymie Intel's long-held advantage and stop the competition having time to formulate a counter-attack, the release of the Ryzen 3000 series hasn't been as smooth as AMD would have liked. With turbo speeds struggling to hit their advertised marks, and manual overclocking being null and void in most cases, there are some tricky problems at the heart of AMD's product stack that it is still addressing.

For price and performance, the chips are still impeccable, but they're not without fault. Fortunately, AMD's saving grace comes in the form of PBO and PB2: Precision Boost Overdrive and Precision Boost 2. Easy to confuse, these two technologies are very different from one another. PBO controls how long the processor stays at its advertised boost frequency during heavy load, depending on four main metrics: PPT (Package Power Tracking, the maximum power the motherboard allows over its rails); TDC (Thermal Design Current, the maximum amperage that can be passed through the mobo's VRMs, dependent on temperature scenarios); EDC (Electrical Design Current, the maximum amperage that can be passed through the mobo's VRMs during a spike in demand, over a period of time); and the temperature of the processor. With those metrics, when the CPU is under load, PBO adjusts how long the processor remains at its max boost clock across all cores, before reducing voltage and clock speed simultaneously.

PB2 is a far simpler auto-overclock feature that works in tandem with PBO. It looks at the quality of the cores in the chip and the chip's temperature, then increases the clock speed of one or two cores by up to 200MHz when the load requires single-core performance.

What has any of that got to do with the Asus ROG Crosshair VIII Formula? Well, thanks to PBO and PB2, third-gen Ryzen chips will perform better with stronger VRM solutions and better cooling across the VRM and the processor, and the latest Formulas include support for VRM cooling, thanks to a collaboration project with EKWB to produce a waterblock for the VRMs that works both under air and in a custom loop.

But let's not beat around the bush—this motherboard is not cheap. At $650, it's almost $200 more than the Intel equivalent. This is in part due to the design, but the inclusion of PCIe 4.0 across the M.2 slots is expensive to achieve. That said, Asus is certainly not holding back. Apart from the incredible aesthetic appeal, with subtle mirrored styling and intricate RGB, the Formula also features an arsenal of internal connectivity and rear I/O, and a stunning power delivery system. With a 14+2 power-phase design, with each MOSFET capable of handling 60A, backed up by a microfine alloy choke rated at 45A, all supplied by both an eight-pin and a four-pin EPS power, this is a monster.

And it shows. Performance-wise, it makes a mockery of the competition, hammering in 3,174 in Cinebench R15, 75 seconds in Fry Render, and 63.24fps in X264. There's no doubting how big a deal that VRM solution is. Even so, the reality is, in our testing suite, this is all done at stock. With a liquid-cooled loop chilling those VRMs, it's likely it will score far higher thanks to PBO and PB2, and that's where the true brilliance of the Crosshair VIII Formula lies. Despite its vast price, it's hard to deny the genius behind its design. Whether it's connectivity, PCIe 4.0, aesthetics, or outright performance, the Formula is king. **–ZAK STOREY**

VERDICT

9

KICK ASS!

Asus ROG Crosshair VIII Formula

+ **PERSEUS** Incredible VRM solution; performs well out of the box; awesome aesthetic; strong I/O.

− **PERCY JACKSON** Price.

$650, www.asus.com

BENCHMARKS

	Asus ROG Crosshair VIII Formula	Gigabyte X570 Aorus Master	ASRock X570 Taichi
Tech ARP's X264 (Avg fps)	**63.24**	62.57	61.07
Cinebench R15 Multi (Index)	**3,174**	3,106	2,999
Fry Render (m:s)	**1:15**	1:22	1:26
AIDA64 Memory Latency (ns)	**70**	76	76
CrystalDisk QD32 Sequential Read (MB/s)	4,979	**5,013**	4,996
CrystalDisk QD32 Sequential Write (MB/s)	**4,285**	4,271	4,272
Power Draw Idle/Load (Watts)	68/177	65/206	**63/155**
Total War: Warhammer II (fps)	**58**	**58**	**58**
Lowest Voltage @ 4.2GHz (Volts)	1.19	**1.17**	**1.17**
Maximum OC Achieved (GHz)	**4.3**	4.2	4.2

Best scores are in bold. Our test bed consists of an AMD Ryzen R9 3900X, 32GB of Corsair Dominator Platinum RGB DDR4 @ 3,600MT/s, an Nvidia GeForce GTX 1080, and a 1TB Corsair MP600 PCIe 4.0 M.2 SSD. *Total War: Warhammer II* was tested at 1440p, on the Ultra preset.

SPECIFICATIONS

Chipset/Socket	X570/AM4
Form Factor	ATX
Memory Support	128GB DDR4 @ 4,800MHz
M.2/U.2 Support	2x M.2 PCIe 4.0 (with Ryzen 3000)
SATA Support	8x SATA 6Gb/s
Max PCIe Support	2x PCIe 4.0 x16 (x8x8)
Rear I/O	4x USB 3.2 Gen1, 8x USB 3.2 Gen2, 5.1 audio, optical audio out, Wireless AX, 1x Intel 1G Ethernet, 1x AQC 5G Ethernet, clear CMOS, BIOS reset

Elgato 4K60 Pro

A superb capture card for serious streamers

elgato
OUT
IN
4K60 PRO

ELGATO GAMING—acquired by hardware giant Corsair in June 2018—has a few capture cards on the market, and if you're into streaming, there's a reasonable chance you already own one. The 4K60 Pro is its latest and greatest, compatible with both PCs and 4K consoles (that's the PS4 Pro and Xbox One X, for those not in the know). As you might have guessed from the name, it's capable of capturing 4K footage at 60fps, and the prerequisites for using it are fairly demanding—in addition to a 4K display to capture the footage, you also need a high-end machine to do the actual video capture. The minimum requirements for this card are a sixth-gen Intel or Ryzen 7 CPU, an Nvidia GeForce GTX 1000-series or newer GPU, or Radeon RX Vega, and Windows 10.

The good news is that the 4K60 Pro is one of the cheapest high-end 4K capture cards on the market—a mere $400, making this a no-brainer purchase for the hardcore streamer. There are likely users out there who will find uses for this card beyond gaming, but that's the primary focus; thanks to integration with Twitch and YouTube, using this card to stream or save high-quality gameplay footage is a breeze.

The 4K60 Pro is easy to set up— slide it into a PCIe x4 slot on your motherboard and screw it into the rear I/O slots of your case, just like a conventional GPU or soundcard. The interface is effectively idiot-proof, with two HDMI ports clearly labeled "in" and "out." In fact, the design on the whole feels pretty survivable; a solid steel cover and adjustable high- or low-profile rear I/O make for a product that doesn't demand experience in PC-building to use—something that makes a lot of sense, given that console gamers are part of the target audience here.

Elgato's usual capture software isn't compatible with the 4K60—it'll register the card, but won't be able to capture anything better than 1080p—so you need Elgato's own 4K Capture Utility for Windows tool. This is a stripped-back version of Elgato's usual capture software, and is only compatible with Windows 10, but it's straightforward to use, and there's nothing stopping you from making further adjustments using third-party software. Elgato's 4K capture software links easily to the likes of Twitch and YouTube, so for straight uploads, it's a cinch to use.

POWER PLAY

While the capture software is barebones right now, Elgato is likely to add to it as 4K streaming becomes more established. Streamers with a penchant for over-editing (we still love you guys, don't worry) might find the current state of the software frustrating, but we're willing to give Elgato the benefit of the doubt for now. That leaves the only real drawback as the need for a powerful PC, but if you're dropping several hundred dollars on a capture card, odds are you've got the system to support it. The 4K60 Pro also has no active cooling, and can get fairly hot after extended use, so a well-cooled case is a necessity.

Even if you're not looking to capture 4K footage, the 4K60 still stands out as the best of the bunch. Thanks to improved pass-through support, the 4K60 can record 1440p gameplay at up to 144fps, or 1080p at a whopping 240fps. There's also the option to install multiple 4K60 Pro cards at once, with interconnected compatibility, although the practical applications of this are limited for all but the most dedicated streamers.

On the whole, there's only so much we can say about this product. It's a capture card. Like a toilet plunger or an umbrella, it's only meant to do one thing, and it does that well. The market is anything but saturated when it comes to good-quality capture cards; even less so in the regions of 4K streaming. Elgato doesn't have much competition, so it would have been easy for it to phone it in with this one. Thankfully, it hasn't; the 4K60 Pro is a great capture card, albeit one aimed decidedly at streaming enthusiasts with high-end PCs. –CHRISTIAN GUYTON

VERDICT
9

Elgato 4K60 Pro

➕ **PROFESSIONAL** Good value; accessible app; easy to set up.

➖ **CONFESSIONAL** Runs hot; no backward compatibility; software is limited.

$400, http://elgato.com

SPECIFICATIONS

Connectivity	HDMI input/output
Compatibility	PCIe x4
Encoding	HEVC/H.265 HDR, AVC/H.264
Supported Resolutions	1080p @ 240Hz, 1440p @ 144Hz, 2160p @ 60Hz
Maximum Bitrate	140Mb/s

Asus Lyra Voice

Decent smart speaker that happens to be a router

THE NEXT STEP for mesh routers appears to be integrating voice assistants into their repertoire. With the release of the Lyra Voice, Asus joins the likes of the Netgear Orbi Voice by releasing a router that also takes a turn as a gateway to the wonderful world of Amazon Alexa. In terms of headline figures, this is very much a router in the same guise as the original Lyra, offering AC2200 connectivity: 400Mb/s at 2.4GHz, and dual 867Mb/s connections at 5GHz.

Before we go any further, it's worth considering how this will fit in your home, because if the Internet connection enters your house in a foyer, under a staircase, or somewhere out of the way, this limits the usefulness of the main selling point of the Lyra Voice as an all-in-one solution. The good news is that the Lyra Voice can work alongside your existing mesh network (or indeed any Wi-Fi router), but in many ways, it's much neater as an all-in-one solution (if your layout will play ball).

The Lyra Voice is different from your normal router in that it boasts a fabric finish and isn't covered in visible antennae. There's a slightly thinner band in the middle adorned with the Asus logo, the light strip used by Alexa to show that it's heard you (and also used during setup to show where it is in the installation process), and four buttons on the top that control volume, mute the speaker, and wake Alexa instantly. Around the back is an on/off switch, as well as two Ethernet ports, and a power connector.

In terms of audio, the Lyra Voice is loud without being overbearing, and it isn't overly bass heavy, which can often be the case with Bluetooth speakers. Speaking of which, when paired as a Bluetooth speaker or streaming directly, it makes for a thoroughly enjoyable musical experience, and thanks to Alexa, it's easy to control as well. As a smart speaker, it impresses—we found talking to Alexa, even from a distance, worked well. The responses are clear, and it was reasonably rare for us to have to clarify any of our questions.

SOFTWARE SORROWS

All good so far, which brings us to our biggest problem with the Lyra Voice—its software. We initially tried setting up the Lyra Voice as an additional unit to an existing mesh network, but couldn't get it to complete the installation, despite picking up the network we wanted it to attach to easily enough. We then tried setting it up in router mode, but came unstuck at the end of installation as well. It transpired that there was a problem with the setup app, and judging by the comments on the app store, this problem had been ongoing for some time.

After several weeks, an update finally became available, and at this point we could finish the installation, and use it as intended. However, we then witnessed performance that was well below what you'd expect from a modern router—5Mb/s, even if standing next to it. Fast-forward a few more eagerly downloaded updates, and we finally have a router that performs well. But as experiences go, it hardly instils confidence.

Once configured properly (and updated), the actual throughput you'll enjoy from the Lyra Voice is impressive, especially at range. It's a consistent performer, too. Indeed, for a single router, it managed much better coverage than we would have expected, and for modest sized homes, there's a lot to like here as a standalone router.

However, the initial software problems left a bad taste in our mouths, and while it now works as intended, this did knock our confidence in Asus's ability to maintain the software in a reasonable timeframe. That said, the combination of a smart assistant and decent Bluetooth speaker makes for a tempting addition to normal router capabilities. And while it may cost a little more than a normal router, it feels like a good return on the investment. **–ALAN DEXTER**

VERDICT 7

Asus Lyra Voice

➕ **CONNECTED** Performs decently; operates as a Bluetooth speaker; Alexa works well.

➖ **DETACHED** Software needs work; not ideal for every layout.

$220, www.asus.com

SPECIFICATIONS

Connectivity	AC2200 (400Mb/s on 2.4GHz; 867Mb/s + 867Mb/s on 5GHz)
Antenna	6x Wi-Fi, 1x Bluetooth
Memory	256MB Flash, 512MB RAM
Ports	1x Gigabit WAN port, 1x Gigabit LAN port
Encryption	WPA2-PSK, WPA-PSK, WPA-Enterprise, WPA2-Enterprise
Dimensions	10.6 x 3 x 3 inches

Endgame Gear XM1

If everything seems under control, you're not going fast enough

ENDGAME GEAR'S focus is perhaps the most singular we have ever seen of a niche peripheral manufacturer, and that's saying something, given the company we often keep. The XM1 is, says EG, nothing more than the world's fastest mouse. Partial credit for that really must be given to your wrist. It's certainly not very fast without it. But let's move past the terrible dad jokes: How exactly do you go about making the fastest mouse in the world?

Part the first, you use Pixart's class-leading PMW3389 sensor, which eyes up your surface at a maximum of 16,000 cpi. That in itself should be enough, because using the XM1 at full resolution (and indeed any mouse that also carries said sensor, such as the Razer Deathadder Elite) results in an unusably twitchy level of sensitivity, so much so that we're not positive that there's a human on Earth who could take full advantage of it. Given that the PMW3389 is not unique to the XM1, though, there has to be more.

OK, how about the switches? These are from Omron, which is always a solid check mark, and on the top face of the mouse, there's barely any travel to actuate them. Fast. Once they're clicked, there's some kind of analog sensing inside (don't ask us how it works) that promises to take switch polling below 1ms, which combines with 1,000Hz USB polling to make for a minuscule click-to-register ratio—our testing definitely showed that it was fast, though we're perhaps not esports enough to detect any perceptible difference. Middle click on the wheel is a heavy short-throw switch, which is appreciated, and the wheel itself is low profile, with a pleasantly soft notched movement.

Those, at least bar the analog switch gimmick, are features you commonly find in other mice. Fast ones, admittedly, but other mice nonetheless. But the XM1's commitment to speed does not end there. There's some of the slipperiest PTFE pads underneath, in all four corners, ensuring friction is never an issue. The whole thing has been cut down to only the essentials—there are two LEDs on board, but they're underneath, so you'll never see them—giving the mouse body a remarkably light construction, and giving your wrist less work to do. It's a whole high-velocity package; the only aspect that perhaps could have been made speedier is the edge button construction. This left-edge pair has more travel than a transatlantic businessman embroiled in a scandal from which he is desperate to escape, and a spongy feel that doesn't match the solid construction of the rest.

A clever touch, and one that needs to be aped more elsewhere, is the base-mounted resolution button. When you've gotta go fast, sausage-fingering a DPI switch on the top of the mouse is the last thing you want. This one doesn't change unless you want it to, and you can configure the four resolutions it toggles through in software. Despite Endgame Gear being a relatively new company, its software is actually pretty accomplished, with button remapping, lift-off sensitivity, and an exponential smoothing function tucked away in there for those who desire a more syrupy cursor.

This would normally be the point in a relatively positive review where we complain about the price, but EG has succeeded there, too—this doesn't have the traditional esports premium placed on it. The only real negatives are frivolous wants rather than lacking features: It's a lot less exciting than many mice in terms of its design and decoration—not a sliver of grippy silicon on the edges, no outward LEDs—and a braided cable would make us slightly more confident in the longevity of its hard wire. And the speed? This is certainly fast enough to satisfy anyone whose current mouse feels too sluggish, but we suspect such rubber-wristed mousers are realistically few and far between. **–ALEX COX**

VERDICT 8

Endgame Gear XM1

⊞ **SPEED** Super-light; super-sensitive; super-simple.

⊟ **KILLS** Rather unexciting; comes with a questionable cable.

$60, http://endgamegear.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	Up to 16,000 cpi
Sensor Model	Pixart PMW3389
Polling Rate	1,000Hz
Programmable Buttons	5
LEDs	RGB x2 (on base)
Cable Length	6 feet
Weight	2.5oz

Fractal Design Vector RS

Compromises and direction changes

IT SEEMS we're long past the days of Fractal's iconic Define series. With the launch of its Vector RS chassis, it's left a lot of questions among the tech community as to where the company is heading. Compared to the prestigious Meshify and Define R6 cases, the Vector RS is somewhat lacking. Both the quality of the materials and the design decisions fail to keep up with modern expectations, and those failings don't help justify that $180 price tag. Yet before we consign this to the sin bin, let's look at what it is, exactly, that's grinding our gears.

At first glance, and on Fractal's website, the Vector seems to be a stylish chassis. Its clean sharp lines convey a sense of modernity, following in the footsteps of the dramatic Meshify series. Its angular roof, solid front panel, and melding of tempered glass, RGB, and metal bring it to life in a way that, from the site at least, give it some serious character. In real life, however, things are not so good. The black glass is prone to fingerprints, the angular roof less than desirable, and the standard painted steel that lines everything else attracts every mark going, and is something we're more used to seeing in the sub-$100 market. Some may find it stunning, but it's just not that appealing to us especially with the likes of the Phanteks Evolv X and NZXT H710i costing around the same.

Then there's the airflow. To be fair, the front of the chassis has a good half inch of ventilation running down either side, but there's not a whole lot front or top. In its default configuration, you get just two 140mm fans, the same ones found in the Define R5 and R6, and that's about it. The roof panel is also a solid tempered glass affair, but Fractal does include a replacement mesh option with additional mounting for a top rad, too.

The interior layout is as strong as we saw in the Define R6, which launched in late 2017. Mostly because it's identical. For those keen on 3.5-inch hard drives, this supports up to 11, with six included, all mounted in the front of the chassis; the drives and caddie are removable to allow for better airflow or liquid-cooling support. But bear in mind that if you do take that route, there's no obvious way of hiding the cables from the front I/O and any fans behind it, once the towering HDD structure is gone.

You also get two 2.5-inch hard drive mounts on the back of the motherboard tray, a full-length PSU cover, plenty of rubber cable grommets, and mounting locations for a vertical GPU (for which you need to buy a separate adapter).

Once you're past the poor quality materials and aging interior design, and have circumvented the airflow issue with some powerful static pressure optimized fans, the Vector RS is quite pleasant to build in. We didn't find any major foibles outside of having to rigorously cable-manage our front fans.

The thing is, the Vector RS is just a two-year-old case design with some new panels and RGB thrown on top, and that's not good enough. You can pick up a Define R6 for $142 now, so you're paying $40 more for some angular external panels. This might have been fine back in 2017, but when you have the likes of the H710i, Evolv X, Lian Li PC011-Dynamic, Silent Base 801, Enthoo Luxe II, and H510 Elite all nipping around the same if not lower price point, it makes the Vector RS feel utterly lackluster. Unless you absolutely need 11 3.5-inch drives, the Vector RS is one to be missed. **–ZAK STOREY**

VERDICT

6

Fractal Design Vector RS

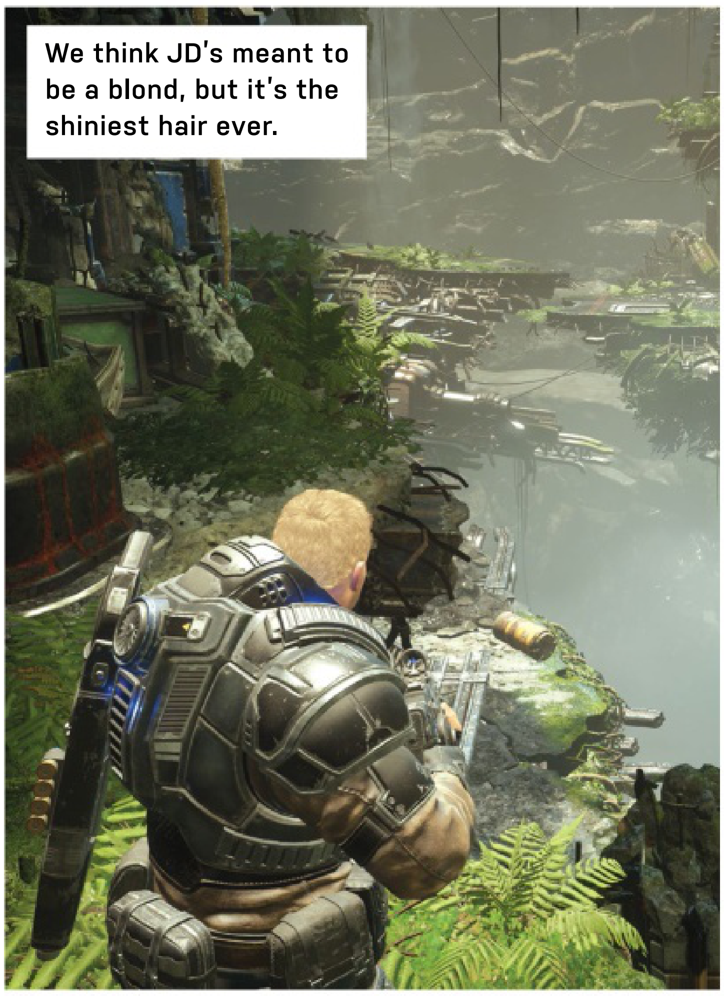
➕ **NEW ARCHITECTURE** Strong internal layout; good level of hardware support.

➖ **14NM++++++++++** Poor default airflow; pricey; two-year-old internal design; below-par materials.

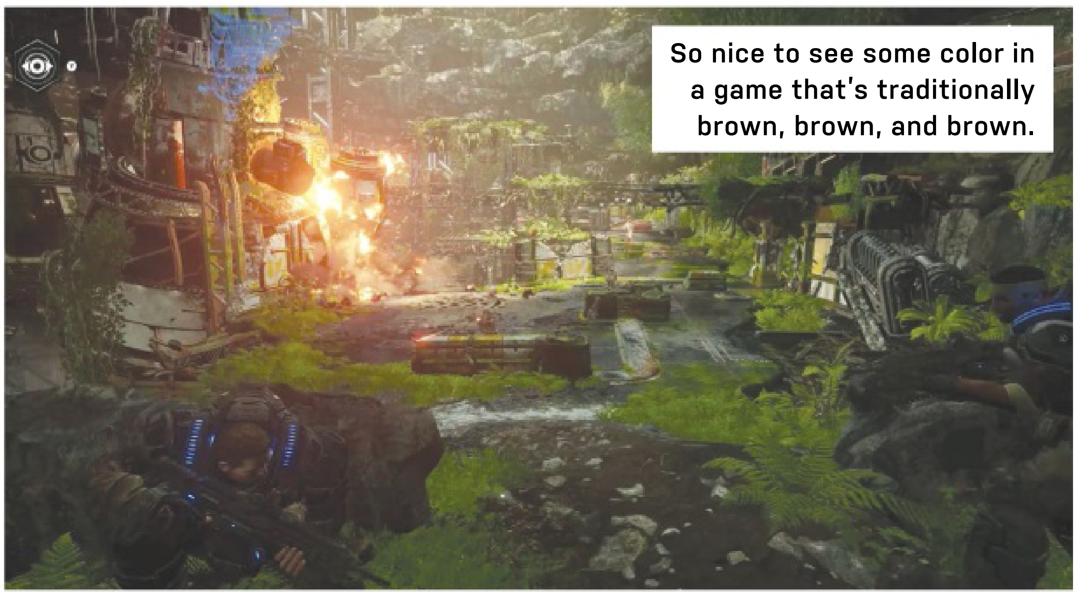
$180, www.fractal-design.com

SPECIFICATIONS

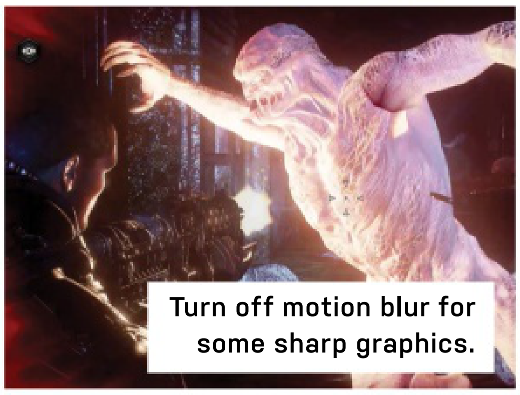
Form Factor	Mid-tower
Motherboard Support	E-ATX (up to 285mm), ATX, microATX, ITX
Colors Available	Black
Window Available	Windowed only: clear and smoked
3.5-Inch Support	11 (6 included)
2.5-Inch Support	4 (2 included)
Radiator Support	360mm front, 420mm roof, 120mm rear, 240mm bottom
Fan Support	Up to 3x 140mm front, 3x 140mm roof, 1x 140mm rear, 2x 140mm bottom
Dimensions (WxHxD)	9.2 x 19.6 x 21.7 inches
Graphics Card Clearance	17.3 inches
CPU Tower Clearance	7.3 inches
Weight	27.87lb



We think JD's meant to be a blond, but it's the shiniest hair ever.



So nice to see some color in a game that's traditionally brown, brown, and brown.



Turn off motion blur for some sharp graphics.

Nasty little Juvies still swarm in packs.

THIRD-PERSON SHOOTER

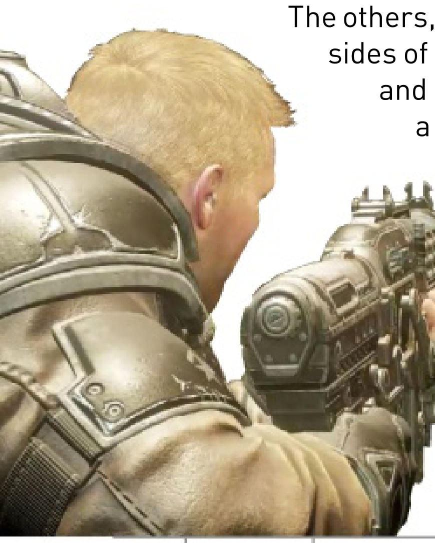
Gears 5

Space jocks find color, nuance, and orbital death rays

FOLLOWING ON FROM the decidedly earnest *Gears of War 4*, *Gears 5* drops half the name and a lot of the seriousness, because running into battle wearing half a metal workshop and carrying a gun with a chainsaw affixed should be fun, dammit.

This time it is. Half of the game plays out the way the series always has, your muscular team of largely interchangeable protagonists hunkering down behind cover that's conveniently just the right height, before letting rip with red-hot bullets at monsters trying to do the same to you. Kait is meant to be the lead character, but it's so easy to change her that we did it by accident. Her slightly slimmer frame and smaller armor may make her look like a supermini surrounded by pickup trucks on the freeway, but she's an interesting character supported by great voice acting.

The others, well, in a game about sides of beef charging around and whooping, subtlety is a relatively new idea, and the rest of the cast are the same meatheads they have always been, only this time written with an eye for humor that was missing before. Even the robots have some amusing things to say.



Graphically, it's pulled ahead of the pack. The "destroyed beauty" aesthetic has always been strong, but *Gears 5* takes it in new directions. It throws you about, never keeping you in a location long enough for it to get boring. And while there are some glitches, it's the best-looking and most colorful *Gears* to date, and runs very nicely on moderate setups.

Downloading the Ultra textures is worth it if your graphics card is recent and has an "80" in the name; it'll even run at 4K 60fps with them. An intelligent scaling system keeps it simple for everyone else.

Jack, your flying, often invisible, robot pal, now gets upgrades in the form of "components" left carelessly lying around for you to collect. They all look the same, but can enhance any of four sets of abilities, meaning you can build a specific damage-dealing bot, or opt for something that can handle multiple tasks. He's also now a playable character, if you fancy something different.

Get far enough into the campaign—there are four acts, none of which outstays its welcome—and things change. It starts experimenting with an open world, sending you off on a strange contraption pulled by a sail. It's too empty, but you move fast through it, and lacks any real sense of exploration, thanks to a radar that points things out to you. What it gives is a glimpse at what's to come: *Gears 7*, perhaps, becoming a more *Far Cry*-like experience (with chainsaw bayonets).

All of this is playable in splitscreen co-op, one of the more generous implementations we've seen recently, and with co-op-friendly multiplayer modes—such as old friend Horde and the new Escape—to underline just how much more fun it is to play with a friend.

That's not a new idea, but most of what's in *Gears 5* is either new or refreshed. Sure, there's active reloading and swingy grenades and chainsaws, just like in 2006, but with its renewed emphasis on big dumb fun, it feels distinctly 2019. Which is a good thing. **–IAN EVENDEN**

VERDICT **8**

Gears 5

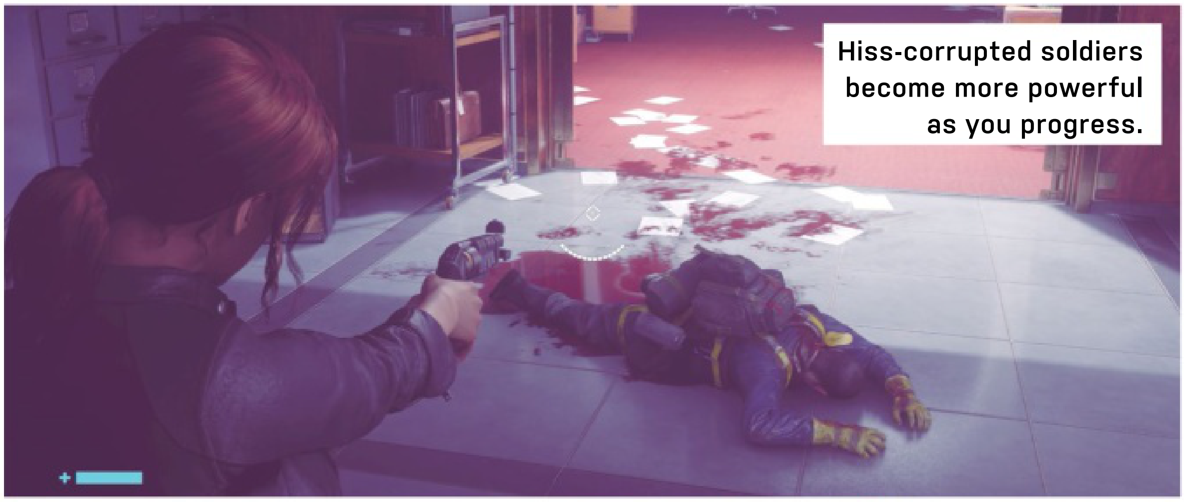
+ CHAINSAW Freshens up the series with great graphics, performances, and humor.

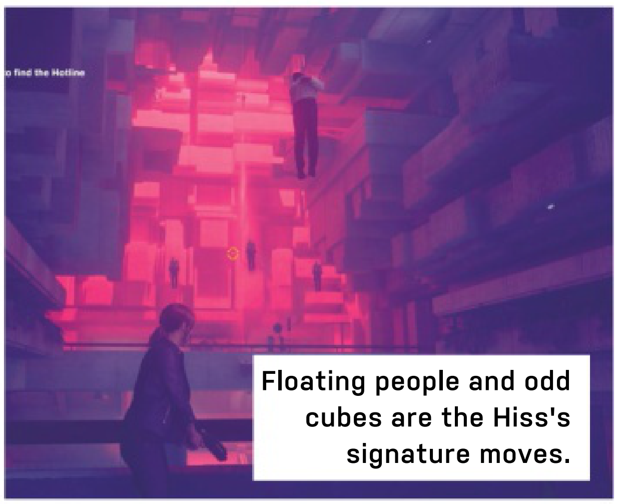
– COLESLAW Occasionally glitchy; lunk-headed characters; AI slow to revive you.

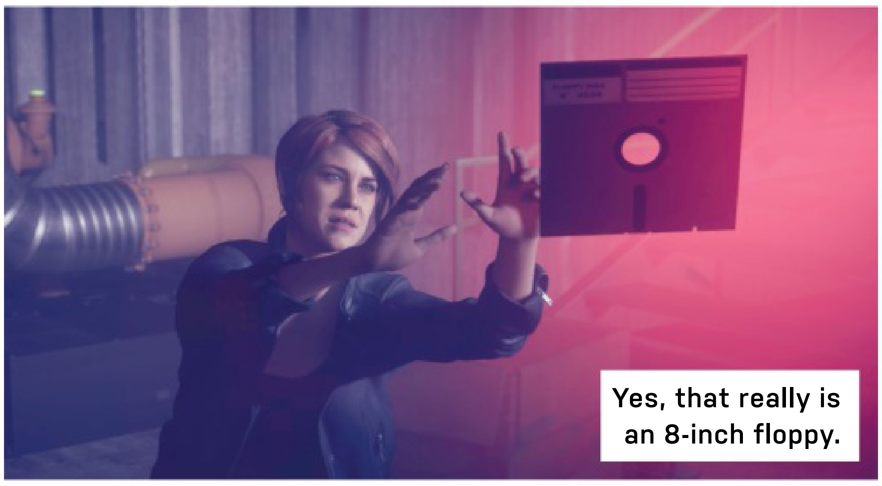
RECOMMENDED SPECS Core i5 Skylake/ Ryzen 3; 8GB RAM; GTX 970/RX 570.

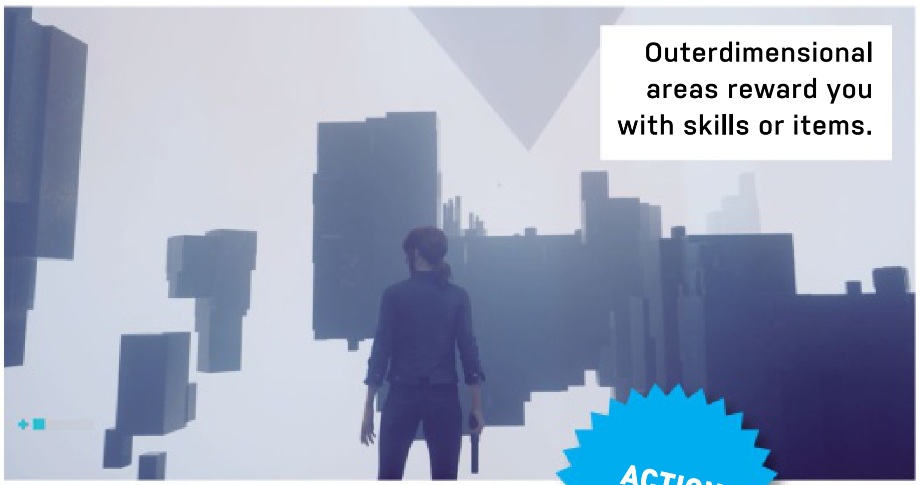
$60, http://gears5.com, ESRB: M

© MICROSOFT


Hiss-corrupted soldiers become more powerful as you progress.


Floating people and odd cubes are the Hiss's signature moves.


Yes, that really is an 8-inch floppy.


Outerdimensional areas reward you with skills or items.

ACTION ADVENTURE

Control

A game that makes you question things, like games

THE FEDERAL BUREAU of Control sounds like something a certain type of Facebook group might rebrand the FBI as, but in this mind-bending, space-twisting third-person-sorta-shooter, it's a real thing.

Well, mostly real. It resides in a building called the Oldest House that only appears to those who need it, or by accident. Its brutalist exterior houses an interior that's either infinite and unshackled from our hum-drum trio of dimensions, or taking up a great deal of expensive New York real estate. Our money is on the former.

Influenced by Mark Z. Danielewski's *House of Leaves*, the neverending corridors and offices of the Oldest House could be seen as a satire on modern working conditions, but this is something far greater. The FBC is charged with investigating paranormal incidents, and its HQ is filled with portals, dimensional rifts, mailbags, and floating staff.

When you get there, the levitating laborers are inert, but events frequently cause them to become hostile. An entity called the Hiss sends security guards and possessed military units against you, but your only defence is a shape-changing gun that, well, let's just say you don't find it in the most joyful of circumstances.

What could be a standard prowl around some corridors shooting at anything that moves is made into something special by the splicing of videogame and live-action, and the way you never know what's going to happen next in a game where the ceiling could twist open to reveal a whole new dimension at any moment.

There's more. You'll eventually gain powers to levitate yourself, and fling items from the environment at enemies. You'll find a weird janitor, shoot monsters, discover what happened to your brother, fight an eight-inch floppy disk that throws tables at you, and take vague orders from an ineffable "board" that might be in charge. It sounds like a mess, but there's a strong sci-fi story pulling you through it all, and that's enough to get you traveling from one side of the building to the other many times, occasionally popping outside real space to gain knowledge or powers.

For all its office-based looks, *Control* is a good looking game at times. Everything is physics-enabled, to the extent that knocking over a projector allows the film to keep playing from its new position. There's also one of the toughest implementations of ray tracing we've yet seen, turning every surface into a reflection, if you've got the card for it. That janitor polished the floors gooood.

There have been few games recently that use videogames' ability to pierce the thin film of reality we surround ourselves with so effectively. Unreality pours through the cracks in *Control's* world, and you're never more than a few steps away from bursting through into strange worlds and Montana hotels.

But if this sounds like a glorious experiment in freeform gaming, be prepared to slam up against some traditional game design at times. A system of keys keeps you out of new areas until you've discovered them, some save points need to be cleared of enemies and activated, and there are boss fights that punctuate major story revelations.

Control is cleverly made, frothing with ideas, and toys with your expectations like a cat with a bird. It's almost enough to make you forget you're playing another third-person shooter. –**IAN EVENDEN**

VERDICT
8

Control

+ CONTROL Packed with ideas, weirdness, cinematics, and craftsmanship.

− REBEL Level gates and boss fights feel artificial against the broader back story.

RECOMMENDED SPECS i5-7600K/Ryzen 5 1600X; 16GB RAM; GTX 1060/RX 580.

$60, www.remedygames.com, ESRB: M

© 505 GAMES

LAB NOTES

JOANNA NELIUS, HARDWARE STAFF WRITER

Healthy Skepticism of Google Stadia

Nice option, but it's not a PC. Not even close

GOOGLE STADIA IS A NICE OPTION for a niche segment of gamers, such as minimalists who live in tiny homes, or kids whose parents don't want the hassle of the hardware that comes with games. But that's all cloud gaming should be, or at least can be at this point—another option for consumers. Gaming on local hardware doesn't come with all the latency and packet loss issues that cloud gaming does, not to mention the fact that if your Internet provider puts a data cap on your plan, gaming on Stadia is going to suck up all your available data, and "hello" overuse charges or throttling.

Yet I can't help but feel that Google is treating Stadia as though it's going to change gaming as we know it. In a recent interview with *Edge Magazine,* Google's VP of engineering, Madj Bakar, made a bold claim that Google thinks "in a year or two we'll have games that are running faster and feel more responsive in the cloud than they do locally," and it will be because Google will have perfected a type of machine learning that predicts what button you'll press before you press it—theoretically.

I can't help but be extremely skeptical of Google's claims. Fast response times are a necessity in the middle of an intense shoot-out or when stringing together a complicated combo of moves in a fighting game. How will it predict what I want to say to another character in a game like *Life is Strange?*

You only have to cast your mind back to a decade ago, and you'll remember that many people were thinking PC gaming was on the brink of extinction, but look where we are now. Only a massive restructuring of the world's Internet is going to result in cloud gaming being on the same level as PC or console gaming—and that's not happening any time soon.

New tech is great, but it's not going to replace gaming as we know it.

ALAN DEXTER

Executive Editor

AMD's decision to launch the Radeon 5500 to OEMs first is interesting, but it does make sense when you think about what that GPU is capable of. Available in desktop and mobile trim, it has 1080p gaming firmly in its sights. According to the latest Steam survey, most people game at that resolution. This leads to an obvious problem: Surely everyone who wants to play at that resolution already has the hardware to do so, which is why it's so popular. Not much of an upgrade market, then. But new builds? That makes sense. The Radeon 5500 GPU will be making its way to cards from the usual suspects soon enough, but until then, an off-the-shelf PC is the only way to get one.

BO MOORE

Hardware Lead

I wish PC game developers would let me do something with my second monitor. I'm not talking about stretching my FOV across two monitors—that's what ultrawide displays are for. No, I just wish that more games had an optional feature to take my second monitor and use it for in-game information. It'd be nice to put the map there, for example, or maybe my inventory. Basically, anything that's relegated to menus or small parts of the heads-up display. And in any sort of management sim, I'd love to have those critical information pages constantly displayed next to me instead of buried in menus. Please, developers, let me put my second monitor to good use.

Editors' Picks:
Digital Discoveries

Senior editor, Jarred Walton, and staff writer, Christian Guyton, are excited about very different hardware

AMD RYZEN 5 3600

I love how competitive AMD's Ryzen CPUs are, and the 12-core/24-thread Ryzen 9 3900X gives Intel some much needed competition. It's forcing Intel to cut HEDT prices in half for the upcoming 10th-gen Cascade Lake-X parts. But as awesome as the 3900X is, for less than half the price, I think the Ryzen 5 3600 is the CPU most people should be looking at.

On paper, it doesn't look too impressive. A six-core/12-thread CPU with a base clock of 3.6GHz and a 4.2GHz boost? It's theoretically only 200MHz slower than the 3600X, but in testing it looks like it runs at about 3.95GHz—only 100MHz slower than the 3600X. And you can overclock it if you want to make up the difference.

For heavy multithreaded CPU workloads, the 3900X is about 70 percent faster. But for general PC use and games? The gap there is far less damaging, with the 3900X only leading by around 10 percent—and that's with an RTX 2080 Ti.

Basically, less than $200 gets you a CPU that comes very close to matching Intel's i7-8700K. If you're trying to put together a nicely balanced mid-range PC for around $1,250, I'm not sure there's a better CPU you can buy right now.

$195, www.amd.com

NITRO CONCEPTS S300

I recently bowed to societal pressure and got myself a gaming chair. OK, I lied; my rubbish old desk chair snapped, sending me sprawling to the floor. My new gaming throne is Nitro Concepts' S300, in "Inferno Red," which makes it sound like it should get me fired up for some edge-of-my-seat action. It doesn't—it's a red chair—but I admit I should have done this years ago.

Sitting in this chair is like being gently lowered into the cockpit of a fighter jet. It almost wraps around you, holding and supporting you through gaming binges. Everything is adjustable, from the angle of the armrests to the lumbar support. In my old chair, attempting to stand up after a few hours was a guaranteed pathway to backache. Now, I can slap this bad boy into recline and chill out, safe in the knowledge that I'm in no danger of toppling backward.

Buying a gaming chair is a commitment; if you buy me, it says, you have to play games. No other furniture commands such influence, except a footstool, possibly, which insists you put your feet up. Maybe that's what the S300 is missing....

$280, www.nitro-concepts.com

GEEK TESTED & APPROVED

SanDisk Ultra Dual Drive Type-C 32GB

USB DRIVES! They're not—let's be honest here—very exciting. If, like us, you work in the tech field, you've probably seen a million and one of them. And yet, this diminutive fella had us smiling with almost child-like glee. It's so tiny, packing 32GB of storage into a sliver of metal and plastic barely an inch long. It's Gen 3.1, so it's offering speedy USB transfers (at least, until USB 4.0 rears its beautiful head). But best of all, it's got a little slider on one side, enabling you to swap between a Type-C USB interface on one end and a Type-A connector on the other.

That Type-C connector proves its worth swiftly; while many people are still rocking cases or motherboards without USB-C support, there's a pretty good chance that your phone has a USB-C port for charging and data transfer. SanDisk has its own app, called Memory Zone 3.0, to make managing files on its drives via an Android device a cinch, and it works well. The app is free and not ad-supported, and the drive has a download shortcut preloaded on it to make things even easier. Whether you're using a notebook, tablet, or smartphone, this is one of the best on-the-go storage options available.

Lastly, and this may not quite be in the spirit of an analytical review, it's really rather fun to play with. The design is solid, and the little switch clicks satisfyingly into place at either end when moved. If you're the fidgety type, this serves a dual purpose (no pun intended) as something to keep the fingers occupied while you work. We like it. **–CG**

$22, www.sandisk.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON…

> Uninstall Preference
> Virtual Reality Updates
> PowerShell Tweaks

Virtual Column

As a suggestion, could you start a new section in *Maximum PC* that's dedicated to VR gaming? It is hard to keep track of what is going on in this area. This review does not have to be long, maybe a little column with the latest updates on games, headsets, from HTC, Oculus, and so on.

Also, I have a few more suggestions:
1. When you print a screenshot of a PC monitor or a laptop screen, could you specify what game or location is represented? I am sure that many readers would appreciate this info.
2. When you review a game, can you specify if this particular game is playable from a first-person perspective? Personally, I can't play games that have only a third-person view, so if a game has no first-person perspective, it's a deal breaker for me.

–Oleg Kravt

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: The initial slew of VR hardware didn't quite have the impact that many of us had hoped for, and the whole concept seems to have been keeping itself pretty quiet for a while now. That said, new hardware is on the horizon (and, indeed, the Oculus Quest is currently on one of our test benches, ready for next issue). So, there will be some content on the way, and we do mention anything interesting as and when it arrives, but a dedicated column or section of the magazine would run out of things to talk about relatively quickly.

As for first- versus third-person games, we'll try to point this out (if it isn't obvious enough), and the new signposting on the games should help. It does have us wondering why you don't like third-person games, though….

Total Removal

Don't mail you much, as you rarely miss a trick, but I think you may have missed my favorite free app (November 2019 issue). For "Uninstalling," you decided on IOBit's Uninstaller, with an honorable mention of Geek Uninstaller, but there has been a free version of Revo Uninstaller available for a long time (www.revouninstaller.com/revo-uninstaller-free-download/). I find it to be very thorough in eliminating even those pesky files that programs leave on your machine. Just my two cents. **–Bruce Gray**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: The beauty of this sort of feature is that it opens it up to our readers to pitch in with your own suggestions, exactly as you have done. We have used Revo Uninstaller previously, and have no problem recommending it as well, although we stand by the suggestions in the original feature, too—you have a lot of options.

Libra Clarity

I read the well-written article by Chris Lloyd pertaining to Libra, in the October 2019 issue. I do have a question as to whether I'm understanding the box on page 48. In that boxout, it is stated that each founding member will maintain a validator node. I'm taking this to mean that there will be 28 or so distributed blockchain servers/maintainers. In other words, it will be like bitcoin without the speculation and mining operations. I just want to know whether I'm correct in my conclusion.

–Peter Luptovic

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: It still isn't precisely clear how it will actually work at this stage, but that is our understanding of things as well—a bitcoin-like back end, but without any of the mining. Of course, given the news this issue that PayPal is pulling out, and a few others are considering their position as well, it could mean that some of the behind-the-scenes workings may need to change.

Congressional Error

Reading the September issue's "Quick Start" blurb about Facebook's fine, I'm disappointed. You used Congress as a term for the House of Representatives, but Congress is comprised of both the House and Senate. **–James Breen**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: You're absolutely right. Apologies.

↘ submit your questions to: comments@maximumpc.com

For Science

I have a couple of suggestions for articles that I would find useful in *MaximumPC*.

I know that the *MaximumPC* readership includes a lot of gamers and overclockers; however, there must be a group of readers who would be interested in the kinds of hardware that would be good for scientific computing. You could have an article on floating-point arithmetic and how the CPUs handle it, which would be useful. Floating-point arithmetic is important for efficient running of statistical/analytical/engineering software. Even users who don't need scientific workstations may still want good floating-point performance from their CPUs for running SETI@home or Folding@home. It's difficult to find information comparing CPU floating-point performance (floating point operations per second, or FLOPS), but I found this article on Wikipedia https://en.wikipedia.org/wiki/FLOPS that describes FLOPS, and compares various AMD and Intel CPUs with regard to floating-point performance. It appears that Intel, especially Skylake-X and Xeon, are way ahead of AMD Ryzen and Threadripper on FLOPS. Ryzen might be starting to catch up with Ryzen 3, however.

Video cards also vary greatly in their ability to perform floating-point math, and that could be another feature of the article. Video card floating-point capability brings up another suggestion for an article. Most *Maximum PC* articles on video cards focus on gaming cards. However, many users run CAD and scientific software, so it would be useful to discuss workstation video cards, such as Nvidia Quadro and AMD Firepro cards, and how they are different from gaming and mainstream cards (ECC memory, higher FLOPS, and higher price, unfortunately). Because true workstation cards are so overpriced, it would be good to know which gaming cards also have decent workstation performance. Some do and some don't. This information is very difficult to find.

Finally, the first two items can be tied together in a discussion of how computer systems offload some of the CPU computing load on to the GPU. My understanding is that GPUs are good to use if your computing task can take advantage of thousands of simple redundant cores (CUDA cores, for example), as in video rendering (I think). How are GPUs used in scientific computing? I think that SETI@home benefits greatly from a GPU with a high FLOPS rating, such as a Quadro.

These issues are peripheral to gaming, but on the Asus motherboard forum, I noticed that a lot of the participants who build their own systems and game and overclock also appear to come from scientific and engineering backgrounds. So, I think these areas of interest may overlap among a portion of your readers.

–Paul Gargiullo

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Good suggestion. It's been a while since we've looked at something along these lines, but with the general improvements we've seen from AMD, Intel, and Nvidia of late (and importantly a drop in prices), it's worth visiting again.

WINDOWS MADE FRESH

Ready to reinstall Windows? Are you really? Let's look at your options... By Alex Cox

1 REINSTALLING FOR FUN & PROFIT

SAMSUNG
PNY
ADATA
SU630

[READER SPOTLIGHT]

THE POWER OF SHELL

In the October 2019, Vol, 24, No. 10 issue of my subscription, Alex Cox provided text for PowerShell on page 25, in the paragraph headed "Key Information" When attempting to run the command, I receive the error message:

```
Select-Object : A positional parameter cannot be
found that accepts argument 'I'.
At line:1 char:93
+ ... install\* | Select-Object DisplayName,
Displayversion, Publisher, Ins ...
+          ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~
+ CategoryInfo         : InvalidArgument: (:) [Select-
Object], ParameterBindingException
+ FullyQualifiedErrorId : PositionalParamete
rNotFound,Microsoft.PowerShell.Commands.
SlectObjectCommand
```

Can Alex please check to see whether his command text is correct? **–Jerry Bell**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: The actual text has a tricky space and hyphen in it—there's a space after "Table" before the "-AutoSize" argument. So it should read:

```
Get-ItemProperty HKLM:\Software\Wow6432Node\
Microsoft\Windows\CurrentVersion\Uninstall\* |
Select-Object DisplayName, DisplayVersion, Publisher,
InstallDate | Format-Table –AutoSize > C:\software.txt
```

Hopefully this resolves your problem.

GitHub Blocking Iran

I think Alex Campbell's article called "GitHub Shuts the Gates for Sanctioned Countries" (October 2019 issue) misses who this will really hurt. The government of Iran has no intention of placing its code on US servers, but Iranians have been involved in open-source projects for decades; their work can be most obviously seen in the translations of many open-source projects to Persian. Blocking Iranians from working on GitHub does little to hurt the Iranian government, but hurts Iranian computer programmers and regular Iranian computer users, and indirectly the rest of us who could benefit from their work on open-source projects. **–David Starner**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Actually, Alex made a big thing in the article about it not really affecting the Iranian government, but rather the everyday guys and gals who use GitHub. This does include those translating code to other languages, though.

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HISTORY OF THE PC
How it all began, and still defines today's rigs PG. 40
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Build your own versatile PC right now! PG. 32
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THE BUILDS

BUDGET

INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$55
PSU	Corsair CX450 80+ White 450W **NEW**	$50
Mobo	ASRock B450M R4.0 AM4	$70
CPU	AMD Ryzen 5 2600	$120
GPU	Zotac Gaming GeForce GTX 1660 6GB **NEW**	$220
RAM	8GB (2x 4GB) Patriot Viper 4 @ 3,000MT/s **NEW**	$39
SSD	120GB Crucial BX500 2.5-inch	$23
HDD	1TB Seagate Desktop ST1000DM003	$34
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$15

Approximate Price: $626

IF YOU'RE ASSEMBLING a budget gaming PC, grab a Ryzen 5 2600 right away. Not only is it on sale for a paltry $120, but it comes packaged with three months of Xbox Game Pass on PC, which includes access to recent releases such as *Gears 5*, *Blair Witch*, and *Metro Exodus*. We've made some small savings elsewhere in this build, too. Swapping our Gigabyte GTX 1660 GPU for the same card from Zotac Gaming saved us $10, and price fluctuations in 8GB memory kits spurred us to head back to America and trade our Team T-Force RAM for the Patriot Viper 4 kit—functionally identical with the same latencies and speed, but a few dollars cheaper. Lastly, the Corsair VS450 is no longer on sale, but the CX450 is—a simple enough swap to keep our price down. We made a saving of $33 dollars against last month, with minimal change in performance; certainly a win.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$95
PSU	500W EVGA 500 BR 80+ Bronze	$50
Mobo	MSI MPG X570 Gaming Plus **NEW**	$170
CPU	AMD Ryzen 5 3600X	$240
Cooler	AMD Wraith Spire	N/A
GPU	Sapphire Radeon RX 5700 8GB	$330
RAM	16GB (2x 8GB) G.Skill Ripjaws V @ 3,200MT/s **NEW**	$68
SSD	250GB Samsung 970 Evo Plus M.2 PCIe	$75
HDD	1TB Seagate Desktop ST1000DM003	$34
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,162

AMD IS KILLING IT with the game deals right now. There's no price drop this month on the Ryzen 5 3600X, but orders now come with a copy of either *Borderlands 3* or *The Outer Worlds*, both great new titles. Sapphire's Radeon RX 5700 has some deals tied to it, too, including Xbox Game Pass and *Ghost Recon: Breakpoint*. It's also $20 cheaper than last month, which frees up a bit of cash for us to play around with. The first order of business was to upgrade the motherboard, because last month we chose the most budget X570 mobo we could find. This time around, we're going with MSI's MPG X570 Gaming Plus, an extra $10 netting us a heat shield for the M.2 drive. A slight price rise in said M.2 drive—the Samsung 970 Evo Plus—wasn't enough to persuade us to switch it out, but we did replace the memory, going for G.Skill's Ripjaws V series this month.

TURBO

UPGRADE OF THE MONTH

MSI MPG X570 GAMING PLUS

Yes, it does look as though it was designed by Reaper from *Overwatch*. That's OK, though; at just $170, the MPG X570 Gaming Plus delivers a lot of high-end motherboard features, from M.2 heat shielding to server-grade PCB, and intelligent power delivery systems. It's the perfect accompaniment to a mid-range Ryzen 3000 chip, such as the 3600X, provided you can look past the black and red design. A tricked-out rear I/O, including HDMI for integrated graphics and a gen-3.2 USB-C port, is just the perfect cherry on top. MSI also happens to be one of our favorites when it comes to straightforward BIOS UIs, so that's a bonus, too! **$170, www.msi.com**

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THERE'S A LOT GOING ON in the high-end desktop CPU arena. AMD's 16-core Ryzen 9 3950X is set to replace second-gen Threadrippers, while the third gen of Threadripper chips is hot on its heels, too. By the time you read this, those chips may well be available; watch this space, because we might finally be swapping out the trusty 2950X. For now, though, second-gen Threadrippers are dropping in price, saving us $60 on the CPU for our Turbo Build.

With that money on the table, we looked to make improvements here and there. First up was memory, and while we stuck with G.Skill, we're going for a 3,600MHz kit of Sniper X instead of last month's 3,200MHz kit. Then we splashed out on a new cooler, going for Corsair's Hydro H100i. This should add more flair, as our previous Fractal Design cooler lacked the H100i's RGB effects.

Our SSD will likely see a big upgrade in the not-too-distant future, too. With both Ryzen and Threadripper 3000 CPUs packing PCIe 4.0, high-speed Gen4 NVMe SSDs will soon be on the menu. For now, we're still making a change, taking the savings from the 2950X (and a small saving made by swapping out the PSU to EVGA's 850 GQ) to upgrade our storage from 512GB to 1TB. This comes with a caveat: a shift from Samsung's Pro line to the Evo series, which will have a small impact on overall drive performance. It's a worthy trade-off for doubling our primary drive capacity, though.

For more of our component recommendations, visit www.pcgamer.com/hardware/buying-guides/

INGREDIENTS

PART			PRICE
Case	NZXT H700i		$182
PSU	850W EVGA 850 GQ 80+ GOLD	NEW	$115
Mobo	ASRock X399 Phantom Gaming 6		$240
CPU	AMD Threadripper 2950X		$770
Cooler	Corsair Hydro H100i RGB Platinum 240mm AIO	NEW	$149
GPU	Zotac Gaming GeForce RTX 2070 Super Twin Fan 8GB		$500
RAM	32GB (2x 16GB) G.Skill Sniper X @ 3,600MT/s	NEW	$150
SSD	1TB Samsung 970 Evo M.2 NVMe	NEW	$170
HDD	2x 3TB Seagate BarraCuda Compute		$160
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $2,536

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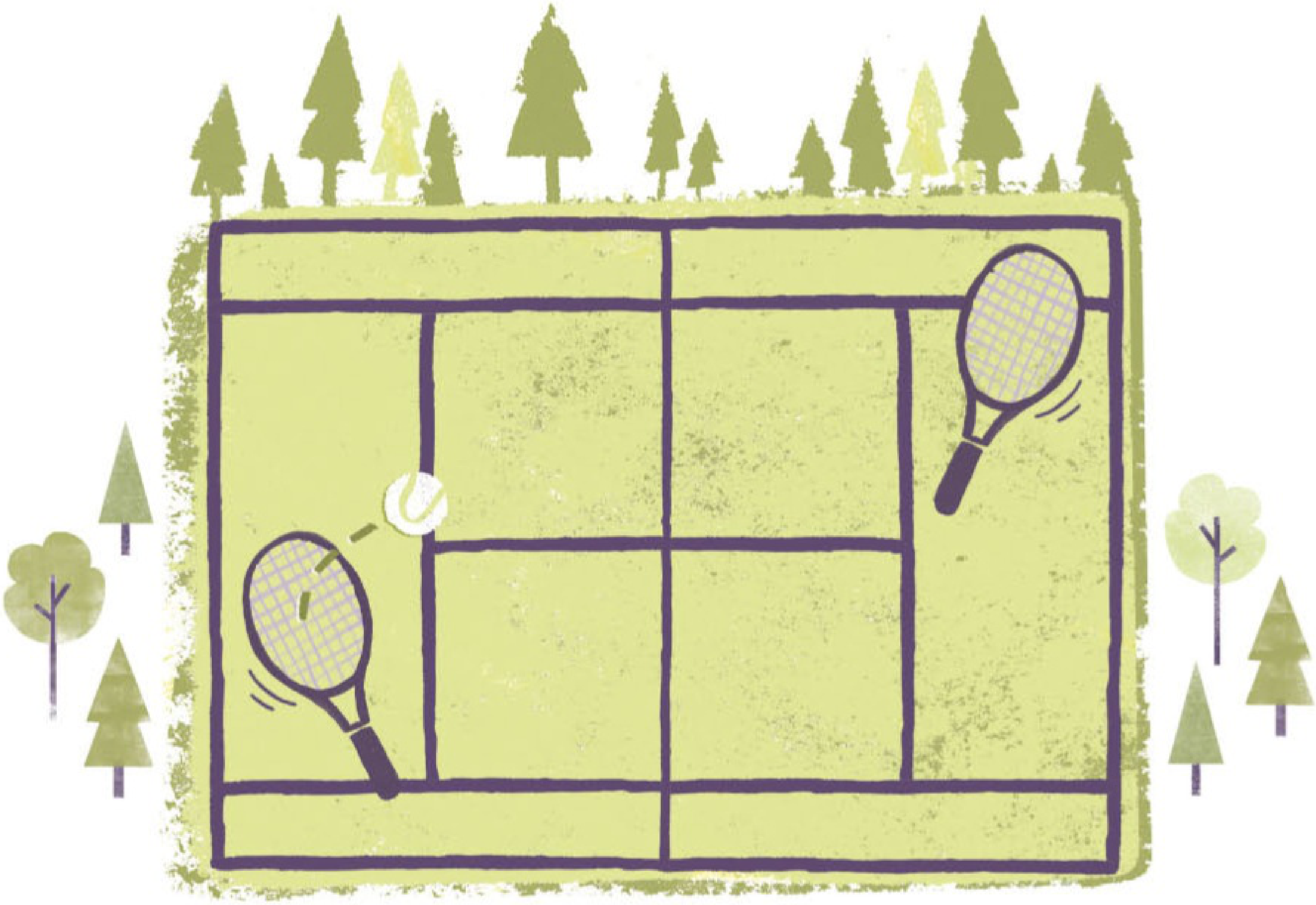

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